

Abstract

The affect associated with negative (or unpleasant) memories typically tends to fade faster than the affect associated with positive (or pleasant) memories, a phenomenon called the *fading affect bias* (FAB). We conducted a study to explore the mechanisms related to the FAB. A retrospective recall procedure was used to obtain three self-report measures (memory vividness, rehearsal frequency, affective fading) for both positive events and negative events. Affect for positive events faded less than affect for negative events, and positive events were recalled more vividly than negative events. The perceived vividness of an event (memory vividness) and the extent to which an event has been rehearsed (rehearsal frequency) were explored as possible mediators of the relation between event valence and affect fading. Additional models conceived of affect fading and rehearsal frequency as contributors to a memory's vividness. Results suggested that memory vividness was a plausible mediator of the relation between an event's valence and affect fading. Rehearsal frequency was also a plausible mediator of this relation, but only via its effects on memory vividness. Additional modeling results suggested that affect fading and rehearsal frequency were both plausible mediators of the relation between an event's valence and the event's rated memory vividness.

Keywords: self, memory, rehearsal, vividness, fading affect bias

An Exploration of the Relationship among Valence, Fading Affect, Rehearsal Frequency, and
Memory Vividness for Past Personal Events

A large corpus of research results shows that the affect associated with negative (or unpleasant) memories typically tends to fade faster than the affect associated with positive (or pleasant) memories (see Kim & Jang, 2014). To our knowledge, Cason (1932) first documented this effect. He used a retrospective recall procedure in which participants described several memories for events that had occurred the previous week; they then reported how those events had made them feel at the time of occurrence. Several weeks later, participants recalled those events and reported how those same events made them feel at the time of recall. Cason found that the reported affect for negative events faded more from event occurrence to event recall than the reported affect for positive events. This phenomenon has come to be known as the *fading affect bias* (FAB).

To this point, the FAB research revival that has followed in the footsteps of Cason has typically pursued one (or both) of two objectives. One of these objectives was simply to verify that the FAB is a real phenomenon. One thrust of this verification-focused research has been to show that the FAB findings are not the result of an artifact of method (e.g., biased event sampling, biased emotion sampling, biased emotion measurement technique), selectivity in participant samples (e.g., participants from the U.S.; young-adult participants; Caucasian participants), or biases in responding (bias in retrospective recall of emotional experiences).

The FAB stood up very well to these various method-based challenges (for a review, see Skowronski, Walker, Henderson, & Bond, 2014; for more recent evidence, see Bond et al., 2015; Henderson, Bond, Alderson & Walker, 2015). For example, the FAB has been replicated using a variety of memory types, including flashbulb memories (Bohn & Berntsen, 2007) and memories

for dreams (Ritchie & Skowronski, 2008). The bias occurs across various ways of measuring affect (for variations, see Ritchie & Skowronski, 2008; Ritchie et al., 2006; Walker, Vogl, & Thompson, 1997; Walker, Skowronski, Gibbons, Vogl, & Thompson, 2003). Landau and Gunter (2009) showed that the FAB occurs regardless of whether event types are collected within-participants or between-participants, and irrespective of the order in which ratings of event emotions are obtained. The FAB has been demonstrated across a variety of positive emotions and negative emotions (Ritchie, Skowronski, Hartnett, Wells, & Walker, 2009), and seems to occur regardless of whether the event-related emotions were active emotions (elated, angry) or passive emotions (calm, sad). Moreover, the temporal characteristics of the FAB seem to be reasonably well behaved. For example, in three diary studies, Gibbons, Lee, and Walker (2011) provided evidence that the FAB had emerged within 24 hours after an event and remained stable for at least 3 months. Other research has demonstrated that the FAB is not a consequence of naïve participant beliefs about their memories: Participants believe that negative memories have longer-lasting emotional effects than positive memories (Ritchie et al., 2009). In addition, a number of studies have found that the FAB emerges across: (1) various regions of the U.S., (2) various ethnicities (e.g., African-American, American Indian, and Puerto Rican), and (3) various age groups (see Ritchie, Batterson et al., 2015; Ritchie, Watson, Roopun, & Skowronski, 2016). Cross-cultural evidence for the FAB is also now emerging (Ritchie, Batterson et al., 2015; Skowronski, Sedikides, Xie, & Zhou, 2015), with FAB evidence coming from England (from both a Caucasian sub-population and a Black sub-population), China, Ghana, Germany, and New Zealand (from both a Caucasian sub-population and a Maori sub-population).

A second thrust evident in the existing corpus of FAB research focuses on moderation of the effect. Research shows that the FAB does not occur for all kinds of events. Ritchie et al.

(2006) found that the magnitude of the FAB was especially small when autobiographical events were perceived to be self-important (also see Ritchie, Skowronski, Cadogan, & Sedikides, 2014), psychologically open (Beike & Wirth-Beaumont, 2005), or self-caused. The Ritchie et al. (2006) results also showed that the FAB was especially large when events were seen as especially atypical of a person's life, when they were judged to be frequently rehearsed, and when they were judged to be rehearsed by means of discussing the events with others. Results reported by Gibbons et al. (2013) linked the FAB to the extent to which events involved alcohol consumption: Negative events related to high alcohol consumption lost their negative affect charge particularly extensively and thus might contribute to reinforce problematic behaviors related to high alcohol consumption.

Research also suggests that the FAB does not occur equally for all kinds of people. For example, research results suggest that the FAB is minimized in dysphoric individuals, such that at the highest level of dysphoria, negative affect and positive affect faded equally (Walker et al., 2003). The FAB is also moderated by an individual's level of anxiety. Research results showed that increased anxiety was associated with both a lowered FAB and lower overall fading of affect for both positive events and negative events (Walker, Yancu, & Skowronski, 2014). Narcissism is another individual difference variable that moderates the FAB. Results from two studies (Ritchie, Walker, Marsh, Hart, & Skowronski, 2015) showed that participants low in narcissism evidenced a large FAB, but participants high in narcissism evidenced a diminished or reversed FAB (i.e., affect for positive events faded more than affect for negative events). Another study showed that narcissism interacted with event type: Those high in narcissism evinced a FAB when they recalled achievement-themed autobiographical events but evinced a reversed FAB when they recalled communal-themed events. These individual difference-related moderations

of the FAB are not limited to the trait domain, but emerge in response to manipulations of states. For example, results from several studies reported by Skowronski et al. (2015) showed that emotional reactions to memories were altered by several manipulations. For instance, when the working self was changed by adopting a third-person perspective during recall, emotional reactions to recalled events were dampened compared to when a first-person perspective was adopted. Additionally, after exposure to a mortality salience manipulation that increased perceived self-worth, emotional reactions to memories were highly positive.

One issue that has arisen in FAB research and theorizing concerns the relation of the FAB to characteristics of personal event memories, such as a memory's recallability, clarity, or vividness. For example, some researchers have reported that positive personal event memories tend to be better recalled than negative personal event memories (e.g., Thompson, Skowronski, Larsen & Betz, 1996; Levine & Bluck, 2004). Citing such findings, Skowronski (2011) suggested that both the FAB and this positivity bias in personal event memory might reflect the operation of cognitive processes and motivational processes that work towards the promotion and maintenance of self-positivity. The fact that both the FAB and personal event memories are driven by common processes and motives suggests that, at the least, the FAB ought to be correlated with how well an event is recalled.

Some researchers go even further down this path, suggesting that there might be a causal relation between the FAB and memory quality. For example, when examining the content of personal event recall, Holmes (1970) found better recall for positive events than for negative events. Holmes wondered if the greater fading of affect for negative events than for positive events could cause this positivity bias in memory content, speculating that events that maintained their affect over time were more likely to be well-recalled. Walker et al. (1997) pursued a

different line of causal reasoning. They were interested in the idea that the FAB might be a consequence of event recall. In this view, in comparison to negative memories, the superior recall for positive memories causes memories to retain their affective potency across time. However, neither the analyses reported by Holmes nor the analyses reported by Walker et al. provided support for their causal theorizing.

Recent research reported by Ritchie and Batteson (2013) also examined these alternative causal theories. They found evidence from analyses of retrospective recall data that over time memories for negative events lose more episodic detail (they assessed a memory's colorfulness) than positive memories. Their analyses also yielded a FAB effect in the affective reactions that people had to their memories. These outcomes replicate ones reported by Holmes (1970) and Walker et al. (1997). However, Ritchie and Batteson also assessed the possible causal linkage between memory content and the FAB by applying advanced statistical modeling techniques to their data. Results from these analyses suggested that: (1) differences in the rated colorfulness of positive personal memories and in the rated colorfulness of negative personal memories was a statistically plausible cause of the FAB (as suggested by Walker et al. 1997), and (2) contradicting Holmes' thesis, the FAB was not a statistically plausible cause of differences in the rated colorfulness of positive personal memories and the rated colorfulness negative personal memories. In other words, the results reported by Ritchie and Batteson suggest that the FAB may be partially driven by the extent to which positive memories and negative memories differentially fade across time.

The Present Study

The study that we report in the present article continues to explore the possible causal relation between the content of event memory (in our case, it was participant ratings of a

memory's vividness) and the FAB. Following Ritchie and Batteson (2013), we brought contemporary statistical modeling techniques to the table when examining this issue. However, Ritchie and Batteson included event rehearsal as a covariate in their models, but did not investigate the possible causal role rehearsal might play in the relations between event valence, the FAB, and the strength of event memory. We moved beyond Ritchie and Batteson by adding rehearsal frequency to the statistical models that we explored. Rehearsal frequency is a logical variable to use in this regard, for it has been shown in past research to have relations to both the FAB (e.g., Ritchie et al., 2006; Walker, Skowronski, Gibbons, Vogl, & Ritchie, 2009) and to the self-reported strength of personal event memories (Thompson et al., 1996). Indeed, memories that are rehearsed often tend to both retain their affect over time and are reported as being well-recalled (Thompson et al., 1996). One line of thinking suggests that rehearsal frequency can influence the extent to which events retain or lose affect over time in two ways. One effect might be direct, such that high rates of rehearsal might tend to maintain affect because people persevere over their failures or savor their successes. A second causal route suggests that rehearsal frequency can help to retain memory strength, which should promote the retention of event-related affect.

To explore such possibilities, in the study that we report, we solicited positive event memories and negative event memories from participants. We assessed the extent to which these memories retained their affect over time, the extent to which these memories were thought to be rehearsed, and the extent to which these memories remained strong. We operationalized memory strength in terms of *memory vividness* (see D'Argembeau & Van der Linden, 2006). We assumed that those well-remembered events ought to retain their episodic characteristics, so that well-remembered events would produce a sense of vividness at their recall.

To explore possible causal relations among the fading of affect between event occurrence and event recall and the variables of event valence, event rehearsal frequency, and memory vividness, these variables were entered into various causal models. One model linking these variables (see Figure 1) followed in the footsteps of Walker et al. (1997) and Ritchie and Batteson (2013). This model was primarily interested in whether there was an indirect path from event valence to event recall-prompted affect fading that was plausibly mediated by event rehearsal frequency and/or by event rehearsal frequency's effect on event memory strength (i.e. memory vividness). In other words, in this model: (1) positive events may be rehearsed more often than negative events (path a); (2) this differential rehearsal frequency itself may be responsible for the fading of event-related affect (path b); (3) event valence may be linked to the vividness of event recall either because of differences in rehearsal frequency (path c) or directly (path d); and (4) these vividness differences in event memories may also contribute to the affect produced at event recall (path e). Also of interest was whether there would be a plausible direct effect between event valence and event-prompted affect fading (path f) after the indirect effects through rehearsal frequency and memory vividness were accounted for statistically. We term this *FAB-focused model 1*.

However, because many of the variables in our study are measured (instead of manipulated), alternative causal models that use these variables can be constructed. One alternative model that was explored (see Figure 2) was similar to *FAB-focused model 1* in that the model suggested that one indirect path from event valence to the FAB worked through the effects of both event rehearsal frequency and/or memory vividness. However, in this new model the causal ordering of rehearsal frequency and memory vividness was reversed from *FAB-focused model 1*. In other words, in this new model: (1) positive events may be recalled more

vividly than negative events (path a); (2) this differential vividness itself may be responsible for the fading of event-related affect (path b); (3) event valence may be linked to differential rehearsal frequency of positive events and negative events either because of differences in memory vividness (path c) or directly (path d); and (4) these rehearsal frequency differences for positive events and negative events in event memories may also contribute to the fading of affect produced at event recall (path e). We term this *FAB-focused model 2*.

However, one might ask whether the FAB causes memory vividness or whether memory vividness causes the FAB. Unlike those ideas that are tested by our two FAB-focused models, it is possible that memory vividness might *arise* due to the affect at event recall, rather than contribute to the affect at event recall (Holmes, 1970). In an attempt to pursue the answer to this query, two additional alternative causal models follow in the footsteps of Holmes (1970), who hypothesized that memory vividness might be a consequence of the affect prompted by event recall. Following Holmes, both of those models examine the idea that there is an indirect causal pathway from event valence to vividness of personal memory event recall.

One plausible model (depicted in Figure 3) assumes: (1) the affect prompted by positive events may fade less than the affect prompted by negative events (path a); (2) affect fading may be directly responsible for the perceived vividness of a personal event memory (path b); (3) event valence may be linked to rehearsal frequency either directly (path d) or indirectly from affect fading (path c); and (4) these differential rehearsal frequencies may also contribute to the vividness with which events are recalled (path e). Also of interest was whether there would be a plausible direct effect between event valence and the vividness of event recall (path f) after the indirect effects through rehearsal frequency and affect fading were accounted for statistically. We term this model *memory vividness-focused model 1*.

A second seemingly plausible model in the footsteps of Holmes (1970) (depicted in Figure 4) assumes: (1) positive events may be rehearsed more often than negative events (path a); (2) rehearsal frequency may be directly responsible for the memory vividness of a personal event (path b); (3) event valence may be linked to the fading of event-prompted affect either directly (path d) or indirectly through rehearsal frequency (path c); and (4) the extent to which event-related affect fading affects the vividness of event recall (path e). Also of interest was whether there would be a plausible direct effect between event valence and the vividness of event recall (path f) after the indirect effects through rehearsal frequency and affect fading were accounted for statistically. We term this model the *memory vividness-focused model 2*.

Research overview. Thus to summarize, our initial analyses looked for several straightforward effects: (1) the affect prompted by a positive personal event memory should fade less from event occurrence to event recall than the affect prompted by a negative event memory; (2) positive memories ought to be reported as being rehearsed more often than negative memories; (3) frequently rehearsed events ought to be events that are vividly recalled, (4) vividly recalled memories should evince less fading of affect than non-vividly recalled memories, (5) frequently rehearsed memories should evince less fading than events that are not frequently rehearsed, and (6) positive memories should be more vividly recalled than negative memories.

If these effects emerge, then the causal modeling analyses will proceed. Each of the four models that we have outlined will be examined to see how well they fit the data. Of particular interest would be whether such analyses are especially supportive of a particular causal sequence. For example, one issue of interest was whether differential memory vividness for positive events and negative events was a statistically plausible cause of the FAB (as in the *FAB-focused models*) or whether the FAB was a statistically plausible cause of differential memory

for positive events and negative events (as in the *memory vividness-focused models*). A second issue of interest was whether rehearsal frequency might have direct effects on the fading of affect (*FAB-focused models*) or whether its effects worked through memory vividness (*FAB-focused model 1s*). A third issue of interest was whether, in predicting the vividness of event recall, the more plausible model was one in which rehearsal predicted the fading of affect (*memory vividness-focused model 1*) or was one in which the fading of affect predicted rehearsal (*memory vividness-focused model 2*).

Method

Participants

Participants included 100 people recruited from Amazon's Mechanical Turk (MTurk) worker pool (69% women). This sample size was determined *a priori* based on past research investigating the FAB using designs similar to ours (e.g., Ritchie & Skowronski, 2008, $N = 82$). However, because we collected the data using Mturk, which has not been commonly used in the FAB literature, to ensure that a sufficiently large event sample would remain after data cleaning we decided to collect a larger sample size than has typically been obtained in past FAB research.

Twenty participants started the survey, but dropped out before finishing. We included in our analyses only data from those MTurk participants who completed the survey and filed for payment. Responses from six additional participants were deleted because they wrote nonsense text in the open-ended response boxes.

Thus, analyses included data from 94 participants. Their average age was 39.33 years ($SD=14.88$, range=18-77). Most participants were White (79.6%; 6.5% Black, 4.3% Asian, 3.2% Hispanic, 6.5% other). All participants were recruited from the United States. On average, there was a time lag of 27.65 min between the time at which participants accepted the

assignment on Mturk and the time at which a participant reported that the assignment was completed. Participants received \$.25 for participating.

Procedure

Each participant was prompted to recall eight memories of events from their life that occurred no more than 10 years ago (for a similar procedure, see Ritchie et al. 2009). They were asked to recall memories for events that were unique in that they did not happen repeatedly and occurred at a particular place and time. Participants were prompted by the survey to recall each of the eight memories one at a time. The valence of the memories recalled was a within-participants variable. Participants were prompted to recall four events about which they felt positively at time each the event occurred (positive valence). Participants were also prompted to recall four events about which they felt negatively at the time each event occurred (negative valence). To minimize the possible influence of the order in which events of the two different valences were recalled, the order in which participants were asked to recall negative events and to recall positive events was randomized across participants.

For each prompted memory, participants provided a short title so that they could be asked about that specific memory later in the study. Participants also wrote a short description of the event. At the time of event description, participants also provided ratings of the extent to which they rehearsed each event, the vividness of their memory for each event, and the intensity of the affect experienced at the time the event occurred (initial event affect). After recalling and rating all eight memories on these three characteristics, participants were shown the short title for each memory, and were asked how each event made them feel now that they were recalling the event (current event affect).

Materials

Event rehearsal. The single item “Since it happened, have you thought or talked about this event?” was used to measure event rehearsal for each recalled event (adapted from Ritchie & Batteson, 2013). Participants responded to this item on a scale that ranged from 1 (*Not at all*) to 6 (*As often as any event in my life*). Responses for this item were normally distributed with a skewness of $-.29$ ($SE=.18$).

Memory vividness. Fourteen items (adapted from D’Argembeau & Van der Linden, 2006) were used to measure memory vividness. The individual items were presented with scales that differed in scale length. The most general item “How vivid is this memory” was presented with a five-point response scale ranging from 1 (*No image at all*) to 5 (*Perfectly clear as if I were actually seeing it*). Other items, such as “While remembering the event, I feel as though I am reliving it,” were presented with a six-point response scale ranging from 1 (*not at all*) to 6 (*completely*). Participants responded to yet another set of items using a seven-point response scale that ranged from 1 (*not at all*) to 7 (*completely*). An example from this latter set of items is “While remembering the event, I feel that I travel back to the time when it happened.” Because of the different response scale lengths, the items could not be directly combined into an index. Instead, the responses were first separately standardized for each vividness item. After standardization, the responses for each participant were averaged across vividness items. This calculation was done separately for positive events and for negative events (α for positive events $=.94$, α for negative events $=.95$).

Affect Intensity. Participants responded to a measure of initial affect intensity and a measure of current affect intensity for each recalled event (from Ritchie & Batteson, 2013).

Initial affect intensity. The item that measured initial affect intensity was “How positive or negative did the event make you feel at the time it occurred?” Participants responded to this item on a scale from 1 (*extremely negative*) to 7 (*extremely positive*). Responses were recoded to reflect a scale from -3 to +3 with the sign matching negative affect or positive affect. Prior to analysis, those responses in which the initial affect intensity of a positive event was rated as neutral or negative ($n = 11$) and responses in which the initial affect intensity of a negative event was rated as neutral or positive ($n = 25$) were coded as missing data.

Current affect intensity. The item that measured affect intensity at event recall was “How positive or negative does the event make you feel when you recall it now?” Participants responded to this item on a scale from 1 (*extremely negative*) to 7 (*extremely positive*). These responses were again recoded to reflect a scale from -3 to +3.

Affect fading score. A fading affect score was usually calculated for each item by subtracting the absolute value of the current affect intensity score from the absolute value of the initial affect intensity score. However, on occasion the affect associated with a memory changed in valence over time. For example, a memory could occasionally change in valence from very positive affect (+3) at occurrence to very negative affect at recall (-3). When these valence changes occurred, we capped the difference score at 0 (producing a maximum difference of 3) so that the affect change was not reflected in the difference score.

This decision is rooted in both theory and research practice. Affect “fading” was originally conceived of as occurring when emotions decreased in intensity from occurrence to recall, with a floor at 0 (no emotion). However, not all events exhibit fading. In the lag from event occurrence to event recall, events can retain their affect (fixed affect) or can intensify in their affect (flourishing affect). Moreover, when affect is measured on a bipolar scale (as in the

present research), some events evince valence change (flexible affect). Collectively, these non-fading events happen often: It would not be a surprise to see one-third of the events in a sample be non-fading events.

The FAB research community does not exhibit consensus as to how to handle these non-fading events. One option is to drop all non-fading events from the data, so that the analysis looks only at events that exhibited fading. Critics of this approach suggest that it is excessively conservative, potentially biased, and results in too much data loss. A second approach is simply to take the data “as is,” directly analyzing change scores. Critics of this approach suggest that it may produce the illusory “fading” – average scores that seem to reflect fading can be caused when many events “flip” affect.

Ultimately, preferred data analysis approaches tend to be driven more by theoretical preferences and by data analysis preferences than by results – prior FAB studies have explored these different data analysis approaches, and the FAB has emerged regardless (for additional discussion of this issue, see Ritchie et al., 2009; Skowronski et al., 2014; Walker & Skowronski, 2009). We are uncomfortable excluding from analysis all non-fading events, and we are also uncomfortable using all the data “as is” knowing that “fading” might to some extent reflect affect “flipping.” Our middle-ground position, which includes all data but caps the extent to which the affect flips influence the results, seems to us to be a reasonable compromise. Moreover, we decided on this approach *a priori*, so we are immune from the claim that we chose the data analysis technique that produced the best results.

Results

Initial Results

Responses to the eight memories provided by each participant were examined to see if frequently rehearsed events were also events that were vividly recalled. This possibility was explored using multiple regression analyses, which has been the analytic technique used in many fading affect bias studies (see Ritchie et al., 2015). Given the clustered nature of the data, as in past research (Gibbons et al, 2013; Ritchie & Batteson, 2013), a nominal-level participant variable was included in all analyses. This technique “partials out” between-subject variance in the analysis from the within-subject variance in the analysis, theoretically allowing tests of the within-subject effects (e.g., event valence) to be uncontaminated by between-subject effects (see Cohen & Cohen, 1983, Chapter 11).

After controlling for individual differences in responding via assigning dummy codes to participants and entering those dummy codes into the regression model, self-reported rehearsal frequency significantly predicted self-reported memory vividness as assessed by the memory vividness index, $b = .15$ ($SE = .013$), $F(1, 654) = 126.36$, $p < .001$, $MSE = .31$.

The responses were also examined to see if frequently rehearsed events evinced less fading of affect than less frequently rehearsed memories. This result emerged from a multiple regression analysis in which self-reported rehearsal was used to predict the difference between affect reports at initial event occurrence and affect reported at event recall, $b = -.13$ ($SE = .025$), $F(1, 606) = 26.69$, $p < .001$, $MSE = .93$.

We also examined whether vividly recalled memories evinced less fading of affect than less vividly recalled memories. This result emerged from a multiple regression analysis in which the memory vividness index was used to predict the difference between affect reports at initial

event occurrence and affect reported at event recall, $b = -.15$ ($SE = .065$), $F(1, 607) = 5.36$, $p = .021$, $MSE = .96$.

For the next three analyses, as in past research (Gibbons et al, 2013; Walker, Skowronski, Gibbons, Vogl, & Thompson, 2003) for each participant and for each event valence dependent measures were separately averaged.¹ Hence, each participant had, for both the positive items they recalled and the negative items they recalled, an event rehearsal frequency average, a memory vividness index average, and an affect fading average. Three analyses used these averages.

One analysis looked for evidence that the affect prompted by a positive personal event memory changed less from event occurrence to event recall (.27) than the affect prompted by a negative event memory (.60). This result emerged from a within-subject ANOVA, $F(1, 93) = 15.48$, $p < .001$, partial $\eta^2 = .143$.

A second analysis looked for evidence that positive memories were reported as being rehearsed more often (5.23) than negative memories (4.52). This result emerged from a within-subject ANOVA, $F(1, 93) = 24.88$, $p < .001$, partial $\eta^2 = .211$.

The third analysis looked for evidence that positive memories (.107) were reported to be more vividly recalled than negative memories (-.103). This result emerged from a within-subject ANOVA, $F(1, 93) = 17.11$, $p < .001$, partial $\eta^2 = .155$.

Model Testing

In four separate models, we examined relations among event valence (positive vs. negative), event rehearsal frequency, memory vividness, and affect fading. In these models, average event rehearsal frequency, memory vividness, and affect fading were calculated separately for the four positive events and the four negative events so that for each participant

there were two scores (one for positive events and one for negative events) for each variable: memory valence, event rehearsal frequency, memory vividness, and affect fading.

We examined the relations among these variables using the method specified by Preacher and Hayes (2004) in Model 6 of the PROCESS macro for SPSS (Hayes, 2009). As in our earlier regression analyses and past research (see Ritchie & Batterson, 2013), we again entered a nominal-level participant variable into all analyses to control for the variance between participants. All effects are bootstrapped estimates based on 10,000 trials. The path analyses conducted in PROCESS used fully saturated models. When the results indicated that any of these paths were not statistically significant, we also modeled the data in MPlus (version 7.3, Muthén & Muthén, 2011) without these paths to obtain fit indices.

FAB-focused model 1. For *FAB-focused model 1*, the PROCESS model analysis tested a total of three indirect effects: one indirect effect from event valence to affect fading through both rehearsal frequency and memory vividness, one indirect effect from event valence to affect fading only through rehearsal frequency, and one indirect effect from event valence to affect fading only through memory vividness. Only one significant indirect effect emerged: The indirect effect that included both rehearsal frequency and memory vividness, $indirect = -.02$ ($SE=.01$) $CI95\% = -.04, -.006$. This effect suggests that event valence had a positive effect on rehearsal frequency, such that positive events are rehearsed more than negative events, $b = .36$, $t(185) = 3.67$, $p = .0003$; rehearsal frequency was positively related to memory vividness $b = .18$, $t(184) = 6.62$, $p = .001$; and memory vividness was negatively related to affect fading, $b = -.29$, $t(183) = -2.87$, $p = .005$. The analysis results did not support the idea that event valence was related to affect fading only through rehearsal frequency, $indirect = -.02$ ($SE=.02$), $CI95\% = -.06, .002$ (see Figure 1 for regression coefficients). The analysis results also did not support the idea

that event valence was related to affect fading only through memory vividness, *indirect* = -.01 (*SE*=.01), *CI95%*=-.04, .006 (see Figure 1 for regression coefficients). Finally, in this model these indirect pathways did not fully account for the relationship between event valence and affect fading: In this model, the direct effect of event valence on affect fading was significant, *direct* = -.11 (*SE*=.05), *CI95%* = -.22, -.01, even accounting for the indirect pathways.

The full model was fully saturated and no fit indices were therefore available for that model. However, because two indirect paths (b and d) were non-significant, those paths were deleted from the model and a model fit test was conducted in MPlus. Several statistical results suggest that the resulting model showed good overall fit to the data. According to Hu and Bentler (1995), a model demonstrates good fit when the Chi-square test of model fit is not significant ($\chi^2(2) = 3.51, p = .17$), the Comparative Fit Index (.99) and the Tucker-Lewis Index (.94) exceed the .95 threshold, the Standardized Root Mean Square Residual (.025) is smaller than the .08 threshold, and the Root Mean Square Error of Approximation (.063) is smaller than the .06 threshold. While the Tucker-Lewis Index and the Root Mean Square Error of Approximation only approach the thresholds, the overall conclusion from examination of these indices is that the model is a good fit to the data.

Thus, the results for this model suggest that the link between event valence and affect fading may be related to the differential tendency to rehearse positive events and negative events and to the differential memory vividness effects for positive memories and negative memories that are produced by such rehearsal frequency. The results fits with the suggestion of Walker et al. (1997) that the FAB may be a consequence of the differential vividness of positive events and negative events in memory. Nonetheless, the model results also suggest that there is an effect of

event valence on affect fading above and beyond that which occurs through rehearsal frequency and memory vividness.

FAB-focused model 2. We also considered an alternative model in which the order of rehearsal frequency and memory vividness were reversed from *FAB-focused model 1*. For *FAB-focused model 2*, the PROCESS model analysis tested a total of three indirect effects: one indirect effect from event affect to affect fading through both memory vividness and event rehearsal frequency, one indirect effect from event valence to affect fading through memory vividness only, and one indirect effect from event valence to affect fading through rehearsal frequency only. For this model, only one significant indirect effect emerged (see Figure 2 for regression coefficients). This path worked through only memory vividness (path a→ path b), *indirect* = -.03 (*SE*=.02) *CI*95% = -.07, -.007. This effect suggests that event valence had a positive effect on memory vividness, such that positive events are recalled more vividly than negative events, *b*= .11, *t*(185) = 2.60, *p* = .0100. Then, memory vividness was negatively related to affect fading, *b*= -.29, *t*(183) = -2.87, *p* = .005. Both of the other tested indirect effects were not statistically significant. The indirect effect of event valence on affect fading that worked through memory vividness and then event rehearsal frequency (path a→ path c→ path e) was not viable, *indirect* = -.01 (*SE*=.01), *CI*95% = -.02, .0002 (see Figure 2 for regression coefficients). The indirect effect of event valence on affect fading that worked only through event rehearsal frequency (path d→ path e) was also not viable, *indirect* = -.02 (*SE*=.01), *CI*95% = -.04, .0006. Finally, in this model these indirect pathways did not fully account for the relationship between event valence and affect fading: The direct effect of event valence on affect fading in this model was significant, *direct* = -.12 (*SE*=.05), *CI*95% = -.22, -.01.

Removing the non-significant path e results in a model with two outcome variables. Hence, the model remains fully saturated and no fit test can be computed.

In summary, the results for this model suggests that the link between event valence and affect fading may be at least partially related to differential memory vividness for positive memories and negative memories. This result fits with the suggestion of Walker et al. (1997) that the FAB may be a consequence of the differential vividness of positive events and negative events in memory. Nonetheless, the model results also suggest that there is an effect of event valence on affect fading beyond that which occurs through memory vividness.

Memory Vividness-Focused Model 1. However, one can also take the view of Holmes (1970) and wonder whether the FAB works in the service of promoting vividness of memory. The *memory vividness-focused model 1* is one way to conceive of this view.

The PROCESS model analysis tested three indirect effects for this model. Results from the analysis suggested that all three indirect routes were significant (see Figure 2 for regression coefficients). One effect works from event valence to vividness through affect fading, *indirect* = .02 ($SE=.01$), $CI95\% = .01, .06$. This significant indirect effect suggests that event valence affects affect fading, such that affect for negative events fades faster than affect for positive events (the FAB), which may, in turn, affect memory vividness, $b = -.14$, $t(183) = -2.87$, $p = .005$. A second effect works from event valence to memory vividness through rehearsal frequency, *indirect* = .05 ($SE=.02$), $CI95\% = .017, .09$. This significant indirect effect suggests that event valence may indirectly affect memory vividness, such that positive events are rehearsed more than negative events, which may, in turn, affect memory vividness, $b = .16$, $t(183) = 5.96$, $p = .005$. A third effect works from event valence to memory vividness through the effects of affect fading on rehearsal frequency, *indirect* = .01 ($SE=.01$) $CI95\% = .003, .03$. This

last effect suggests that event valence had a negative effect on affect fading, such that affect for negative events faded faster than affect for positive events, $b = -.17$, $t(185) = -3.24$, $p = .001$; affect fading was negatively related to event rehearsal frequency, $b = -.41$, $t(184) = -3.03$, $p = .003$; and event rehearsal frequency was positively related to memory vividness, $b = .16$, $t(183) = 5.96$, $p = .001$. Finally, for this model, these indirect pathways fully accounted for the relationship between event valence and memory vividness: The direct effect of event valence on memory vividness in this model was not significant, $direct = .02$ ($SE = .04$), $CI95\% = -.05, .1$.

Because one path (f) was non-significant, that path was dropped from the model and the model fit was examined using MPlus. A number of statistical results show that the resulting model showed good overall fit (Hu & Bentler, 1995). The Chi-square test of model fit was not significant ($\chi^2(1) = .32$, $p = .57$). The Comparative Fit Index (1.00) was larger than .95. The Tucker-Lewis Index was 1.02 and thus larger than .95. The Standardized Root Mean Square Residual (.004) was smaller than .08, and the Root Mean Square Error of Approximation (< .001) was smaller than .06.

Memory Vividness-Focused Model 2. A second model that can be considered when thinking about the relation between event valence and memory vividness is presented is *memory vividness-focused model 2*.

The PROCESS model analysis tested three indirect effects for this model. All were significant. In one of these, the relation between event valence and memory vividness worked only through rehearsal frequency, $indirect = .06$ ($SE = .02$), $CI95\% = .03, .1$. As was suggested by *memory vividness-focused model 1*, this significant indirect effect suggests that event valence may directly affect event rehearsal frequency, such that positive events are rehearsed more than negative events, and rehearsal may, in turn, affect memory vividness, $b = .16$, $t(183) = 5.96$, $p =$

.001. In the second indirect path, the relation between event valence and memory vividness works only through affect fading, *indirect* = .02 (*SE*=.01), *CI95%* = .04, .05. This significant indirect effect suggests that event valence affects affect fading, such that affect for negative events fades faster than affect for positive events (the FAB), which may, in turn, affect memory vividness, $b = -.15$, $t(183) = -2.87$, $p = .005$. In the third indirect path, the relation between event valence and perceived memory vividness works through the effect that rehearsal frequency has on affect fading, *indirect* = .01 (*SE*=.004) *CI95%*= .002, .02. This indirect effect implies that event valence had a positive effect on rehearsal frequency, such that positive events were rehearsed more than negative events, $b = .36$, $t(185) = 3.67$, $p = .0003$. Then, rehearsal frequency was negatively related to affect fading, $b = -.12$, $t(184) = -3.03$, $p = .003$. Finally, event rehearsal frequency was then positively related to memory vividness, $b = .16$, $t(183) = 5.96$, $p = .001$. As would be expected from the results of the PROCESS analysis for *memory vividness-focused model 1*, these indirect pathways fully accounted for the relationship between event valence and memory vividness: The direct effect of event valence on memory vividness in this model was not significant, *direct* = .02 (*SE*=.04), *CI95%* = -.05, .1.

Because one path (f) was non-significant, that path was dropped from the model and model fit was examined using MPlus. Statistical results indicated that the resulting model was a good overall fit to the data (Hu & Bentler, 1995). The Chi-square test of model fit was not significant ($\chi^2(1) = .32$, $p = .57$). The Comparative Fit Index (1.00) and the Tucker-Lewis Index (1.02) were larger than .95. The Standardized Root Mean Square Residual (.004) was smaller than .08. The Root Mean Square Error of Approximation (< .001) was smaller than .06.

Discussion

A retrospective recall procedure was used to obtain three self-report measures (memory vividness, rehearsal frequency, affect fading) for both positive events and negative events. Descriptive results from these measures evinced a fading affect bias: The intensity of emotions associated with positive events faded less from event occurrence to event recall than the intensity of emotions associated with negative events. The self-reports of memory also showed that positive events were recalled more vividly than negative events. The self-reports of rehearsal frequency showed that positive events were rehearsed more frequently than negative events.

Causal modeling techniques were used to consider various relations among these variables. In two models, both of which fit the data, event rehearsal frequency and memory vividness were conceived of as contributors to affect fading. In both models, memory vividness was a statistically plausible mediator of the relation between event valence and affective fade. In one model, this memory vividness effect was itself influenced by rehearsal frequency. In the second model, this memory vividness effect did not influence rehearsal frequency, but directly affected affect fading. The results from both models affirm the conclusion of Ritchie and Batteson (2013) that memory vividness was a plausible mediator of the relation between event valence and affect fading. These results add to the Ritchie and Batteson (2013) conclusion by suggesting that rehearsal frequency may be linked to event valence and that rehearsal frequency may influence memory vividness, so that rehearsal frequency may influence the fading affect bias via its influence on memory vividness.

Our models, in which event rehearsal is included as a causal variable rather than as a covariate, extend the conclusion offered by Ritchie and Batteson by suggesting that event rehearsal may play causal role in the understanding of the FAB. Ritchie and Batteson's study

was the first to suggest that vivid imagery might play a causal role in the FAB; ours is the second. Further, our study extends the findings of Ritchie and Batteson by suggesting that rehearsal frequency also plays a causal role in the effects of memory vividness on the FAB.

However, these results might be qualified by the kind of rehearsal that people use when thinking about personal events (see Muir, Brown, & Madill, 2015; Ritchie et al., 2006; Skowronski, Gibbons, Vogl., & Walker, 2004; Skowronski & Walker, 2004). While some forms of rehearsal (e.g., rumination) might serve to maintain both negative affect and positive affect, other forms of rehearsal (social, savoring) might serve to maintain positive affect but minimize negative affect. Both our study and the Ritchie and Batteson (2013) study assessed overall rehearsal frequency but did not address the distinction among rehearsal types with respect to the effect that these may have on affect fading. This nuance can be explored in future research.

Two additional models treated memory vividness as the outcome variable and explored whether affect fading was a statistically plausible mediator of the relation between event valence and memory vividness. In contrast to the conclusions offered by Ritchie and Batteson (2013), the results from both models suggested that affect fading was a plausible mediator of the event valence-memory vividness relation. The models were equivocal as to whether the effect of affect fading on memory vividness was itself due to rehearsal frequency, or whether this relation was itself mediated by rehearsal frequency. However, regardless of the ordering of these two variables, in both models the combination of all the mediated routes from event valence fully accounted for the link from event valence to memory vividness. These memory-vividness focused models are novel and interesting, given past work has discussed fading affect and the FAB as mechanisms that promote healthy functioning (e.g., Walker & Skowronski, 2009). Despite this interest, little work has explored the FAB as a mechanism leading to memory

outcomes. These models deviate from the typical way in which the FAB is researched in the literature. Although the fading affect bias has been replicated numerous times (Ritchie & Skowronski, 2008; Ritchie et al., 2006; Walker & Skowronski, 2009; Walker, Vogl, & Thompson, 1997; Walker, Skowronski, Gibbons, Vogl, & Thompson, 2003) it is typically seen as the outcome of memory processes and not as a contributor to memory.

The reasons for the disparity between our conclusions about these latter two models and the conclusions reached by Ritchie and Batterson (2013) need to be explored in future research. One possible reason for this disparity may lie in the exact details of the models used to explore the data. In their modeling efforts, Ritchie and Batterson (2013) explored the relations among event valence, affect fading, and memory after controlling for rehearsal frequency. Instead, we included rehearsal frequency as a variable in our models. To see if this modeling difference accounted for the results disparity, we conducted an analysis in which we duplicated the Ritchie and Batterson approach. The pattern of results matched the pattern found by Ritchie and Batterson, such that memories for positive events were perceived to be more vivid than memories for negative events, albeit not significantly, $b = .04$, $t(184) = 1.06$, $p = .29$. Further, memory vividness negatively predicted affect fading, such that the more vivid memories were, the less affect fading occurred, $b = -.29$, $t(183) = -2.87$, $p = .005$. However, the indirect effect of memory vividness on the relationship between memory valence and affect fading was not statistically reliable as the confidence interval included zero, $indirect = -.12$ ($SE=.05$), $CI95\% = -.04, .01$. Thus, even when similar models were employed, our results did not match the results reported by Ritchie and Batterson (2013).

A second possible reason for the disparity may lie in how some of the variables were measured. The Ritchie and Batterson (2013) study assessed memory via self-reports of a

memory's colorfulness. The memory assessment that we used reflected overall assessments of a memory's vividness. While both measures were intended to reflect the extent to which a memory retained its episodic qualities, the measures are obviously not identical. A second difference reflects the memory procedure that was used. Ritchie and Batteson (2013) asked people to recall an event that had occurred the day before the recall session. In our study, we allowed participants to recall events that occurred any time in the last 10 years. Because of this methodical difference, our participants had to think further back, up to 10 years ago, to provide ratings of the way they felt when the event occurred than Ritchie and Batteson's participants who recalled how they felt when the event occurred yesterday. Due to this methodological difference, it is possible that the ratings of initial affect that we obtained were more biased by present affect than those obtained by Ritchie and Batteson. Perhaps this difference contributed to the disparity between our findings and those reported by Ritchie and Batteson. An additional difference in the memory procedures used includes when the memory for the event was assessed. Ritchie and Batteson repeatedly assessed memory for the event across multiple ratings sessions whereas we used only one recall session. This methodical difference may have compelled participants in our study to provide more consistent ratings than those in Ritchie and Batteson's study. This difference may explain why we found support for multiple causal models whereas Ritchie and Batteson reported that only one tested model fit their data. A third reason may lie in the participants: Ritchie and Batteson's participants were from Ireland; ours were from the U.S. However, in evaluating these possible differences, note that such differences have tended to have little impact on the FAB data obtained. Despite the differences outlined, both our data and the Ritchie and Batteson (2013) data yielded a fading affect bias and showed that the fading of affect was related to the retention of the episodic quality of memory (colorfulness, vividness).

However, because such data have not often been subjected to modeling efforts, it is not known whether the modeling results obtained reflect the same insensitivity to method reflected in the results obtained on the individual measures.

We include one more method-related note of caution when considering the results that we report. Some participants who began our study did not complete it. Despite the attrition, our attrition rate (13%) was lower than the rate (30%-50%) reported in other research using Mturk samples (Zhou & Fishbach, in press). However, one concern is that dropout rates from MTurk studies might differ across experimental conditions (Zhou & Fishbach, in press). The fact that the key variables in our design were within-participants alleviates this concern. Nonetheless, it remains possible that the participants who dropped out of the study might systematically differ from those participants who persisted to completion. This sampling bias possibility suggests that the results that we report might change if data from these dropouts could be obtained. This argues for a replication of the study using a different sampling method.

Finally, in evaluating our modeling efforts, one must remember that these are models that assess the data “as if” the variables were related in the manner that is modeled. While these models can indicate both that models are statistically plausible and specify the patterns of causal relations among variables that are statistically plausible, they do not actually demonstrate causality. Such causality can be demonstrated only by studies that actually manipulate the variables (see Spencer, Zanna, & Fong, 2005). Although these manipulations are difficult in the context of studies of real-world memory that use personal memories, some opportunities to manipulate variables may present themselves (for a rehearsal manipulation that attempted this approach, see Skowronski et al. 2004).

Coda

Some theorists have proclaimed that “bad is stronger than good” (Baumeister, Bratslavsky, Finkenauer, & Vohs, 2001). While in many domains of psychology negativity is indeed more powerful than positivity, this rule is wrong when focusing on the typical emotional responses that one has to one’s personal memories. Here, good is stronger than bad: Emotional responses to positive memories generally seem to persist for longer durations than emotional responses to negative memories (though there are exceptions). The results reported in the present article suggests that this enhanced positivity is linked to the idea that positive memories are more often rehearsed than negative memories, and that positive memories tend to maintain their vividness longer than do negative memories. However, it remains to future research to explicate more fully the relations among event pleasantness, rehearsal, memory vividness, and affect fading. Additionally, future research is needed to more fully understand the potential of the FAB as a contributing mechanism to memory, rather than an outcome influenced by memory.

Footnotes

¹A reviewer of the manuscript wondered why we averaged scores across items before entering the data into the analysis instead of entering the raw data into the analysis. Retaining the original items would have required the use of statistical models that were more complicated than the ones that we employed (items were nested within valence, which were nested within subjects). By averaging across item valence, we avoided a level of nesting and could approach the analyses using the relatively straightforward regression models that we employed. This approach was perfectly suited to the questions that were asked of the data. Moreover, the models that we employed facilitated comparison to the results provided by Ritchie and Batterson (2013), who used a similar approach to data analysis.

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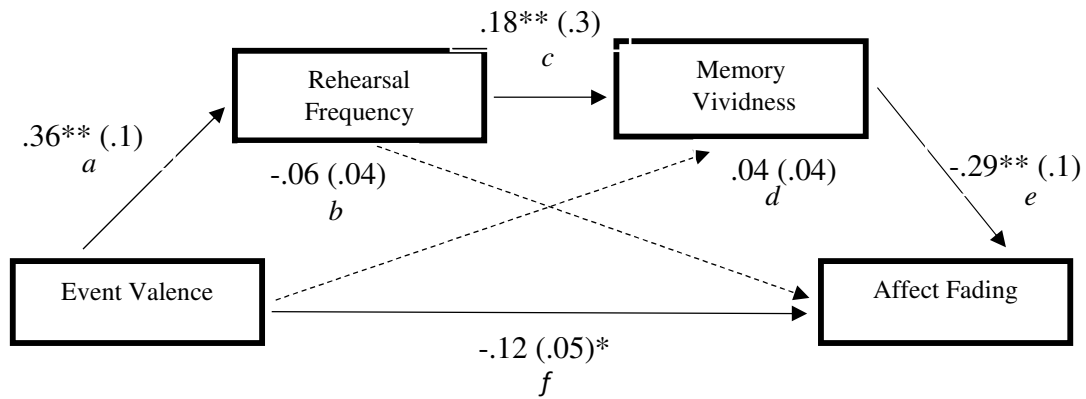


Figure 1: Regression coefficients for the FAB-focused model 1 ($p < .05$, ** $p < .01$). Positive event valence is coded as positive one and negative event valence is coded as negative one. Number of bootstrap samples = 10,000. Regression coefficients are unstandardized.*

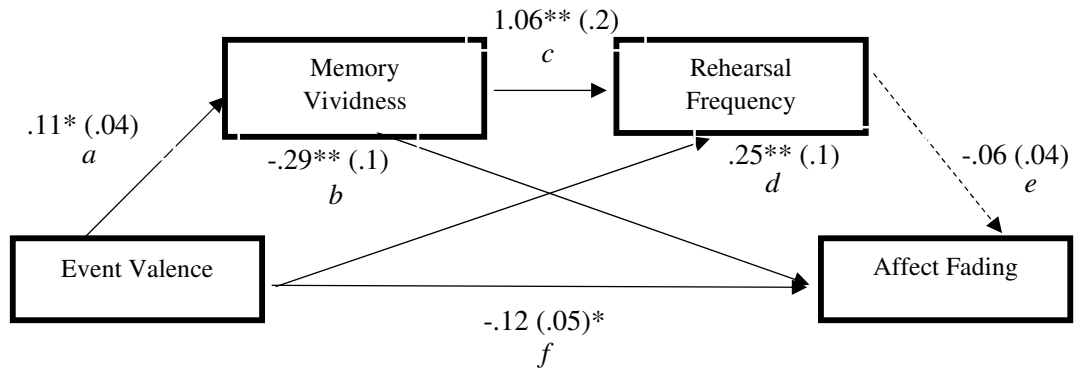


Figure 2: Regression coefficients for the FAB-focused model 2 ($*p < .05$, $**p < .01$). Positive event valence is coded as positive one and negative event valence is coded as negative one. Number of bootstrap samples = 10,000. Regression coefficients are unstandardized.

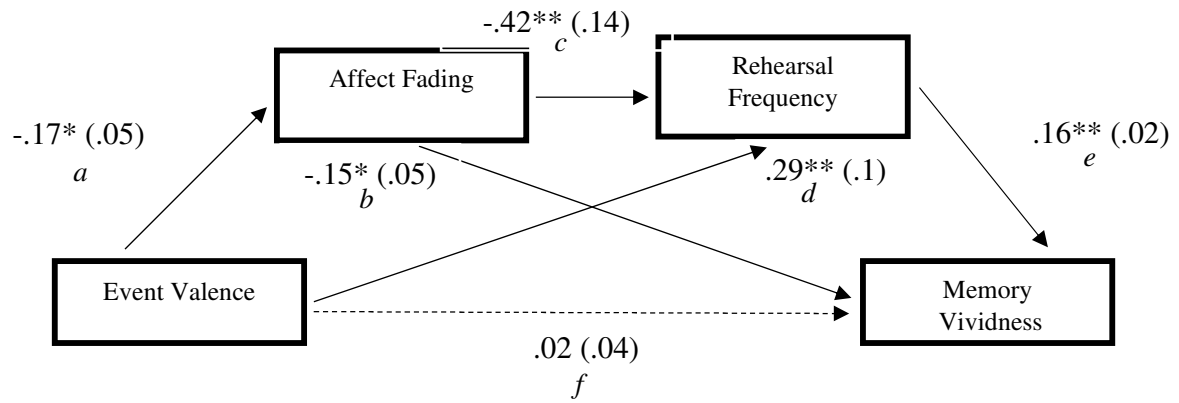


Figure 3: Regression coefficients for the memory vividness-focused model 1 ($p < .05$, ** $p < .01$). Positive event valence is coded as positive one and negative event valence is coded as negative one. Number of bootstrap samples = 10,000. Regression coefficients are unstandardized.*

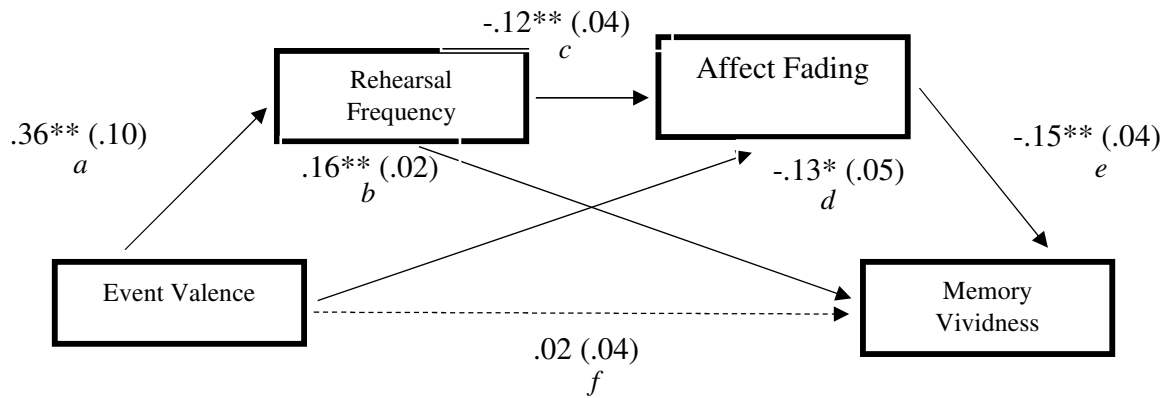


Figure 4. Regression coefficients for *memory vividness-focused model 2* ($*p < .05$, $**p < .01$). Positive event valence is coded as positive one and negative event valence is coded as negative one. Number of bootstrap samples = 10,000. Regression coefficients are unstandardized.