
Article:
Muir, K, Madill, A orcid.org/0000-0002-9406-507X and Brown, C orcid.org/0000-0001-9697-4878 (2023) Reflective rumination mediates the effects of neuroticism upon the fading affect bias in autobiographical memory. Self and Identity, 22 (1). pp. 102-128. ISSN 1529-8868

https://doi.org/10.1080/15298868.2022.2041080

Reflective rumination mediates the effects of neuroticism upon the fading affect bias in autobiographical memory

Kate Muir[a]*, Anna Madill[b] and Charity Brown[b]

*Corresponding author

[a]School of Management, University of Bath, BA2 7AY

Now at Department of Psychology, School of Sciences, Bath Spa University, Newton Park, Bath BA2 9BN.

Email: k.muir@bathspa.ac.uk

[b]School of Psychology, University of Leeds, Leeds LS2 9JT

a.l.madill@leeds.ac.uk, psccbr@leeds.ac.uk

This is the authors' version of a work that was accepted for publication and is forthcoming in Self and Identity. This article may not exactly replicate the final version published in the Taylor and Francis journal.

Abstract

There is a link between personality and the emotional tone of autobiographical memory. Across three studies we explored neuroticism in relation to the fading affect bias (FAB), which refers to the greater fading of unpleasant compared to pleasant emotions in autobiographical memory. One characteristic of neuroticism is the tendency to ruminate over, or repeatedly think about, past unpleasant events, so we also explored event rehearsal and rumination as a mediating process. We found that with increasing neuroticism, there was an associated increase in the frequency to which unpleasant events were privately rehearsed, which in turn was linked to less fading of negative affect. Study 2 showed this effect was specific to rehearsal with the goal to reflect on the event, with Study 3 further clarifying the mediating effect was due to increased frequency of the reflective sub-type of rumination. These results generalized across undergraduate samples and the general population in the UK. We offer new insights into the effects of neuroticism on autobiographical memory and suggest that reflective rumination can be linked to the retention of negative affect in individuals with high neuroticism, which can be interpreted as an indication of maladaptive emotional processing.

Keywords: Fading affect bias, neuroticism, personality, rehearsal, reflection, rumination

Reflective Rumination Mediates the Effects of Neuroticism Upon the Fading affect bias in Autobiographical Memory

Personality is an important influence on the ways in which we perceive, respond to, and remember our emotional worlds. Personality traits such as the 'Big Five' (extraversion, agreeableness, conscientiousness, open-mindedness and neuroticism), shape the phenomenology of autobiographical memories, including vividness and emotional valence (Rubin & Siegler, 2004). Further, the link between personality and autobiographical memory can be thought of as bi-directional. Our sense of self, identity and personality derive from what we remember; equally, our personality can influence what we remember, and how we use our recollections to navigate the world (Rasmussen & Berntsen, 2010).

Across three studies we explore neuroticism, one of the Big Five dimensions of personality, in relation to a phenomenon of autobiographical memory, the fading affect bias (FAB). The FAB describes the greater fading of negative compared to positive affect associated with memories of personally experienced, everyday events (Walker & Skowronski, 2009). The FAB generally concerns autobiographical memories of the events that people experience in everyday life: the FAB does not necessarily apply to extreme negative events that can be the cause of trauma, but those events that characterize the 'ups and downs' of everyday life, such as celebrating a success or failing an exam (Walker & Skowronski, 2009). The FAB is frequently measured using a retrospective recall paradigm. Participants retrieve a number of personally experienced pleasant and unpleasant events from their everyday lives, and rate each for the emotional intensity felt when the event originally occurred, and upon recall in the present day. The difference in emotional intensity between event occurrence and recall is calculated, which generally yields a greater fading in emotional intensity over time for unpleasant events compared with pleasant (e.g., Gibbons, Lee, & Walker, 2011; Ritchie, Batteson, et al., 2015; Walker, Skowronski, Gibbons, Vogl, &

Thompson, 2003). Importantly, the FAB does not appear to be an artefact of differential emotional intensity when events originally occur: unpleasant and pleasant events retrieved by participants are usually equivalent in emotional intensity (Ritchie, Skowronski, Hartnett, Wells, & Walker, 2009; Skowronski, Gibbons, Vogl, & Walker, 2004). The FAB seems to be driven by a greater drop in emotional intensity triggered by the recall of unpleasant everyday autobiographical memories compared to the recall of pleasant ones. The FAB cannot be explained on the basis of better recall of pleasant events compared to unpleasant (Ritchie et al., 2009; Ritchie et al., 2006; Skowronski et al., 2004), and is not thought to occur as a result of experimental artefact, methodological approaches or recall strategies (Landau & Gunter, 2009; Ritchie et al., 2009). Research has thus confirmed the FAB is a robust and reliable effect, which occurs across cultures (Ritchie, Batteson, et al., 2015).

The FAB is proposed to emerge as a result of emotion regulation processes operating on autobiographical memory over the lifespan, which help to maintain a sense of positivity when remembering past events (Walker & Skowronski, 2009). For instance, savoring pleasant events could help their associated positive emotions to be retained in memory (Bryant, 2003), and cognitive reappraisal processes may act to reframe unpleasant events in a more positive light, reducing their negative impact (Levine & Bluck, 2004). Social support and sharing both pleasant and unpleasant events with others are other mechanisms associated with emotional regulation of autobiographical memories (Skowronski et al., 2004; Skowronski & Walker, 2004).

The role emotional regulation processes play in facilitating the fading of the emotional intensity that accompanies unpleasant compared to pleasant memories of everyday events over time is implied by a growing body of research. This research has shown variables indicative of psychological distress (including depression and anxiety) to be negatively associated with the FAB. That is, with increasing levels of these variables, the expected

differential fading of affect, with negative affect fading more than positive, is somewhat minimized (or even absent). Walker et al. (2003) compared groups of non-dysphoric participants (low, moderate or high based on their responses to the Beck Depression Inventory, BDI) to a group displaying dysphoria, the majority of which were mildly depressed (10 and above on the BDI). A general pattern emerged across three replications (but only emerging as significant in one) whereby dysphorics compared to non-dysphorics showed a reduced (or absent) FAB. This was reflected via reduced fading of negative affect, and increased fading of positive affect. Marsh, Hammond and Crawford (2019) replicated and extended this finding by recruiting a sample that included normal to clinically-relevant levels of depressive symptomology, and by treating depressive symptomology within their analysis as a continuous (rather than categorical) measurement scale. They too found that with higher levels of depression, participants displayed a reduced (or absent) FAB. Their findings also provide additional support for this reduction in FAB being due to reduced fading of negative affect. However, for positive affect, their pattern of findings diverged from that of Walker et al., (2003): Marsh et al., (2019) found higher levels of depression to be associated with reduced (not increased) fading of positive affect.

Evidence has also emerged of a negative association between anxiety and the FAB. Walker, Yancu, and Skowronski (2014) divided participants into three roughly equal groups to reflect those with relatively lower, more moderate or higher levels of (non-clinical) trait anxiety within their sample. Anxiety scores were assessed via the Depression, Anxiety and Stress Scale (DASS; F. Ng et al., 2007). The FAB was larger for participants within the lower anxiety group, compared to the moderate and higher anxiety groups. The reduction in FAB was due to reduced fading of both negative and positive events for those in the moderate and higher anxiety groups. Treating anxiety as a continuous, compared to categorical, measurement is likely to further increase sensitivity to detecting relationships between

anxiety and affect fading (Marsh et al., 2019). Nonetheless, despite adopting this analysis type, Marsh et al., (2019) in their study found anxiety to be unrelated to either positive or negative affect fading. However, Gibbons and Lee (2019) conducted a powerful regression-type analysis which combined data from across four separate previously published studies, including approximately 1000 participants, and affect ratings for approximately 3650 events. Treating the four studies as separate datasets had shown that some relationships between the psychological distress variables (anxiety, depression and stress) and FAB emerged as nonsignificant. Analysis of the combined dataset however, confirmed that increasing levels of depression, anxiety and stress (as measured via the DASS) were all associated with reductions in the FAB. For all three variables, the reduction in FAB, was due to reduced fading of negative affect and increased fading of positive affect.

Thus, a reduced FAB has been observed in depression and anxiety. Impaired emotional regulation is implicated in the aetiology of both depression (Joormann & Gotlib, 2010) and anxiety (Cisler, Olatunji, Feldner, & Forsyth, 2010). Since the FAB is thought to emerge as a result of emotional regulation processes operating on autobiographical memory (Walker & Skowronski, 2009), a reduced FAB can be considered to be further evidence of impaired emotional regulation in these disorders. In this paper, we are interested in *neuroticism* in relation to the FAB: a personality variable with associations to impaired emotion regulation, depression and anxiety. Due to these links, we believe that neuroticism may also be linked to a reduced FAB.

Neuroticism and impaired emotion regulation, and relations to the FAB

Neuroticism is argued to be a universal personality dimension (McCrae & Costa Jr, 2013) characterized by a predisposition to experience negative affect (Gross, Sutton, & Ketelaar, 1998; Watson & Clark, 1984). It has been found to influence reactions to everyday negative emotional events or minor stresses (Bolger & Schilling, 1991), and individuals high

in neuroticism are more likely to recall more unpleasant compared to pleasant personal memories (Denkova, Dolcos, & Dolcos, 2012). Pertinently, neuroticism is linked to diminished ability to effectively regulate emotions: individuals with high levels of neuroticism (measured using a neuroticism scale) are more likely to use maladaptive emotional regulation strategies to manage negative emotions, such as suppression (Haga, Kraft, & Corby, 2009). Further, Yang et al. (2020) examined personality variables, including neuroticism, in relation to cognitive reappraisal which is thought to be an adaptive emotional regultion strategy (Gross, 1998a). Yang et al. (2020) asked participants to use a cognitive appraisal strategy to regulate negative emotional responses when presented with a negative stimui, and to self-report the emotions felt. Reappraisal ability was calculated as the difference in subjective negative feelings reported when participants were instructed to regulate emotions, compared to where no regulate instruction was given. There was a negative correlation between neuroticism (as measured by the NEO-PI-R: Costa Jr & McCrae, 1992) and reappraisal ability; in other words, individuals with high levels of neuroticism were less successful at using cognitive reappraisal as an emotional regulation strategy, and reported feeling negative emotions even when trying to regulate them. Potentially, such deficits in emotional regulation ability may also be evident in the form of a reduced FAB in individuals with higher levels of neuroticism.

Moreover, there is evidence of a relationship between neuroticism, depression and anxiety. Feelings of dysphoria (or depressed mood) and anxiety are described as core components of neuroticism, along with worry and sadness (Costa Jr & McCrae, 1992). Neuroticism is also associated with symptoms of both depression (Mineka, Watson, & Clark, 1998) and anxiety (Paulus, Vanwoerden, Norton, & Sharp, 2016). In line with the link between neuroticism and impaired emotional regulation ability, neuroticism has been described as a risk factor predisposing individuals to develop a variety of psychopathologies

such as mood disorders (Lahey, 2009). Thus, given the evidence of an association between neuroticism, anxiety and depression, and that associations between both anxiety and depressive symptomology and the FAB have already been established, it is reasonable to expect a relationship between neuroticism and FAB will also be observed.

In terms of a cognitive mechanism by which neuroticism may exert its effects upon the FAB, *rehearsal* could be a likely candidate. Rehearsing, or thinking about event memories privately without disclosing to other people, is a proposed cognitive mechanism underlying the fading affect bias (Ritchie et al., 2006; Walker, Skowronski, Gibbons, Vogl, & Ritchie, 2009). Some studies have identified an association between the greater the frequency with which individuals report privately rehearsing specific event memories and less fading of both positive and negative affect in memory (Ritchie et al., 2006; Walker et al., 2009). Further, participants can report greater frequency of rehearsal for pleasant compared to unpleasant events, lending credence to the hypothesis that cognitive rehearsal is one of the mechanisms by which the fading affect bias develops in autobiographical memory (Walker et al., 2009).

Marsh, Hammond, and Crawford (2019) examined the relationship between the rehearsal of specific event memories, either by thinking, talking or writing, and depressive symptomology. They found higher levels of depression were associated with participants' reporting more frequently thinking of past unpleasant events and in turn more frequent thinking about past unpleasant event memories was associated with reduced fading of negative affect. This pattern of findings did not hold for talking or writing about events. Potentially, we may expect a relationship to emerge between neuroticism, FAB and the frequency with which participants report voluntarily privately rehearsing past unpleasant events. This may in turn be linked to a smaller FAB, due to less fading of negative affect.

The Present Research

The overarching purpose of the present research was to explore the role of neuroticism in relation to the FAB. Following the majority of previous studies that have explored relationships between individual difference measures and the FAB, we adopt a correlational approach (Gibbons, Hartzler, Hartzler, Lee, & Walker, 2015; Walker et al., 2003; Walker, Yancu, & Skowronski, 2014). In three studies, participants recalled everyday autobiographical events (both pleasant and unpleasant) and retrospectively rated the affect experienced at the time the event occurred and at the current time of recall. Participants also rated the frequency with which they engaged in privately rehearsing these events. All participants were asked to complete a measure of neuroticism (Eysenck's Personality Questionnaire Revised - Short Scale. EPQRS: Eysenck & Eysenck, 1991). Across the three studies we expected to observe an effect of FAB overall (i.e., shown by differential fading of affect associated with unpleasant and pleasant event memories, with greater fading of negative than positive affect). However, we anticipated the size of the FAB to be reduced (or absent) for individuals high in neuroticism. Previous research has found a reduction in FAB associated with depression and anxiety to be consistently due to reduced fading of affect related to events initially perceived as unpleasant. Although, a less consistent picture has emerged in relation to how affect responds over time for events initially experienced as pleasant (Marsh et al., 2019, Walker et al., 2003; Gibbons & Lee, 2019). We similarly test the interaction between event valence (pleasant vs. unpleasant) and neuroticism upon FAB. In line with research examining depressive symptomology and anxiety (both of which are psychological distress variables associated with neuroticism), we anticipated that higher levels of neuroticism would at the very least be associated with reduced fading of negative affect.

Our additional aim was to examine whether event rehearsal could mediate observed relationships between neuroticism and the FAB. In Study 1, we explored the frequency of overall private rehearsal as a mediator. Study 2 went on to include measures of overall private rehearsal frequency, and frequency of specific types of private event rehearsal. Finally, in study 3 we added in measures of the frequency of rumination (and its subtypes of reflection and brooding). Across the three studies, we expected to observe an association between increased overall private rehearsal and a reduction in FAB, a pattern found within previous research (Ritchie et al., 2006; Ritchie, Walker, Marsh, Hart, & Skowronski, 2015; Walker et al., 2009). Exploratory analyses then examined whether the frequency with which individuals reported privately rehearsing overall (Studies 1 - 3), rehearsing for specific reasons (Study 2), or ruminating upon their event memories (Study 3), mediated the observed relationship between neuroticism and the FAB.

Study 1

This study examined if neuroticism moderated the magnitude of the FAB and if this effect was mediated through overall private rehearsal frequency. We used a retrospective recall paradigm, which has been used in much of the FAB literature (e.g., Gibbons & Bouldin, 2019; Gibbons et al., 2015; Gibbons, Horowitz, & Dunlap, 2017; Ritchie, Batteson, et al., 2015; Ritchie et al., 2009; Ritchie, Walker, et al., 2015). Participants recalled three pleasant and three unpleasant event memories and rated each for emotional intensity upon event occurrence and recall. Participants also completed a rating of overall private rehearsal frequency for each event, along with a measure of neuroticism. All measures were completed using an online questionnaire for which there was no time limit for completion. Data was collected between 2010 – 2011.

Method

Participants

One hundred and seventy-four participants took part in the study (144 female and 30 male) ranging from 18-54 years old (*M* = 22.5 yrs., *S. D.* = 5.7 yrs.). One hundred and twenty-five undergraduate students were recruited through a department participant pool scheme and received course credit for participating. Forty-nine university postgraduate students or staff were recruited via advertisements and received a small monetary reward for participating. Participants were treated in accordance with the ethical guidelines of the British Psychological Society and approval for the study was granted by the appropriate Research Ethics Committee of the university where the research was conducted. Informed consent was given by participants in the first page of the online questionnaire.

Procedure and Measures

Measure of Neuroticism. Participants completed Eysenck's Personality Questionnaire Revised - Short Scale (EPQRS: Eysenck & Eysenck, 1991) which measures three dimensions of personality: extraversion-introversion, psychoticism (otherwise known as 'tough mindedness'), and neuroticism. Each scale contains 12 statements, to which participants respond 'yes' or 'no', indicating if the statement accurately reflects their personality. Scores on the EPQR-S range between zero and twelve. Of interest in the current study was the scale measuring neuroticism. There is evidence of the reliability and validity of the neuroticism scale of the EPQ (Eysenck & Eysenck, 1991)[i]. In the current sample the mean neuroticism score was 5.9 (*S.D.* = 3.2), which falls within mean estimated neuroticism scores within the general population (Eysenck & Eysenck, 1991).

Event Memory Retrieval. Participants recalled three pleasant and three unpleasant events that they had experienced within the last 12 months, but not within the last seven days

(Skowronski et al., 2004). For each event, participants were asked to provide a title, which acted as a memory cue later on in the study, and to write a brief description of the event. The order of event memory retrieval was counterbalanced, with approximately half the participants recalling pleasant event memories before unpleasant, and vice versa.

Affect Intensity Ratings and Calculation of Affect Change. For each event participants were asked to rate "*How intense were the emotions you felt when this event originally happened?*" and "*How intense are the emotions you feel when remembering this event now?*", both on a rating scale from 1, representing *not at all emotionally intense*, to 7 representing *very emotionally intense*. Following protocol within the FAB literature (e.g., Gibbons et al., 2013; Ritchie, Kitsch, Dromey, & Skowronski, 2018; Ritchie et al., 2006), a measure of *affect change* for each event was calculated by subtracting emotional intensity at recall from emotional intensity at occurrence. Positive values indicated the intensity of emotion decreased from event occurrence to recall, whereas negative values indicated emotion increased in intensity from event occurrence to recall. The size of the value indicates the extent of change, with greater values indicating greater change in emotional intensity between event occurrence and recall.

Rehearsal Ratings. For each event participants completed a rating scale indicating the frequency to which they had performed any *overall private rehearsal* of that particular event, prior to the study. Overall private rehearsal was defined as *"any time you have privately thought about the event, without discussing it with anyone else."* This rating was made on a unipolar scale from 1 (*not at all*) to 7 (*very frequently*). This single item measure of overall private rehearsal has been used in prior research into the role of rehearsal in the FAB (e.g., Ritchie et al., 2006; Skowronski et al., 2004; Walker et al., 2009).

Results

Analytic Approach

Participants retrieved 1044 events (522 pleasant, 522 unpleasant). Some participants declined to complete the neuroticism measure (n = 12), leaving 972 events available for analysis. We analyzed effects on affect change at the level of the event (event valence: pleasant vs. unpleasant, along with the measure of private rehearsal frequency) and at the level of the individual (neuroticism). As participants recalled multiple events each (three pleasant and three unpleasant), events were nested within participants. Thus, in all analyses, we included a nominal level person variable, to account for the nested nature of the data and control for possible between-subjects effects.

We used the PROCESS macro for SPSS to conduct our analyses, which is widely used and has been successfully utilized for analysis of datasets of a similar nature in previous FAB research (Gibbons et al., 2013; Ritchie, Walker, et al., 2015). We tested two models, which are illustrated in Figure 1 (below). Firstly, we examined if neuroticism straightforwardly moderated the relationship between event valence and affect change (e.g., the FAB) using model #1 within PROCESS (the model pictured on the left in Figure 1). That is, we tested the interaction between event valence (categorical: positive vs. negative) and neuroticism (as a continuous variable) on affect change scores. Secondly, we examined if the effects of neuroticism upon affect change scores were mediated through private rehearsal frequency (as a continuous variable), using model #4 within PROCESS for pleasant and unpleasant events separately. In other words, we tested if neuroticism exerted any effects upon fading of either positive or negative affect, via an influence on the extent to which pleasant or unpleasant events were privately rehearsed. For clarity and space, throughout we report only statistically significant results.

<Figure 1 here>

Moderation of FAB by Neuroticism

There was a significant main effect of event valence (positive vs. negative) on affect change scores, b = .93, se = .16, t (972) = 5.81, p <.001, 95% CI [.62, 1.25], demonstrating the usual FAB: unpleasant affect faded in intensity to a greater extent (M = 1.57, $S.D.$ = 1.51) compared to pleasant affect (M = .68, $S.D.$ = 1.01).

There was no main effect of neuroticism in predicting affect change scores, b = -.01, se = .01, t (972) = -.98, p = .32, 95% CI [-.05, .01]. Figure 2, below, presents mean affect change scores for pleasant and unpleasant events at low (-1 S.D.), mean, and high (+1 S.D) neuroticism levels. There appears to be a slight increase in fading for positive affect, and decrease in fading for negative affect, with increasing neuroticism. However, the interaction between event valence and neuroticism in predicting affect change scores was not significant, b = -.01, se = .02, t (972) = -.52, p = .60, 95% CI [-.06, .03], $R^2change$ = .0002, F (1, 968) = .27, p = .60.

<Figure 2 here>

Effects of Neuroticism on Affect Change Mediated Through Overall Private Rehearsal Frequency

With increases in neuroticism scores, there was a corresponding increase in frequency of overall private rehearsal of pleasant events, b = .05, t (486) = 2.37, p = .01, 95% CI [.009, .101]. Similarly, with increases in frequency of overall private rehearsal of pleasant events, there was a corresponding decrease in the fading of positive affect, b = -.11, t (486) = -4.18, p<.001, 95% CI [-.17, -.06]. Bootstrapped 95% confidence intervals with 5000 resamples confirmed that a mediation model fitted the data: with increasing neuroticism scores, there was greater overall private rehearsal of pleasant events, and in turn greater overall private rehearsal of pleasant events was associated with less fading of positive affect, b = .006, *boot se* = .004, *boot 95% CI* [-.01, -.008].

A similar pattern was found for unpleasant events. With increases in neuroticism scores, there was a corresponding increase in frequency of overall private rehearsal of unpleasant events. b = .07, t (486) = 2.97, p = .003, 95% CI [.02, .12]. With increases in frequency of overall private rehearsal of unpleasant events, there was a corresponding decrease in the fading of negative affect, b = -.29, t (486) = -7.81, p<.001, 95% CI [-.36, -.22]. A mediation model fitted the data, b = -.02, *boot se* = .008, *boot 95% CI* [-.04, -.007]. With increasing neuroticism scores, there was greater overall private rehearsal of unpleasant events, and in turn greater overall private rehearsal of unpleasant events was associated with less fading of negative affect.

Discussion of Study 1

We found that with increasing levels of neuroticism, there was a corresponding increase in the frequency of rehearsal of past pleasant and unpleasant memories. In turn, increased frequency of private rehearsal was associated with retention of both positive and negative affect associated with pleasant and unpleasant event memories.

A similar pattern of reduced affect fading for pleasant and unpleasant events has been observed in relation to anxiety (Walker et al., 2014) and depression (Marsh et al., 2019). Given the associations between anxiety, depression, and neuroticism, our results are therefore not surprising from the perspective of previous FAB literature. However, we note that the the magnitude of effects found for pleasant events were smaller compared to unpleasant events, both in terms of rehearsal frequency (b = .05 compared to b = .07), and subsequent affect change (b = -.11 compared to b = -.29). Thus, we take these intial results with caution until they are replicated.

Now we have established an overall effect of private rehearsal in mediating the effects of neuroticism in the FAB, in Study 2 we aimed to firstly examine if the results of Study 1

replicate, and further explore if the effects of neuroticism in the FAB were mediated by specific types of rehearsal.

Study 2

In Study 1 we explored the mediating effects of overall private rehearsal, but individuals can rehearse event memories for specific purposes. Ritchie et al. (2006) and Walker et al. (2009) reported that participants rehearse event memories for the following specific reasons: (1) involuntary rehearsal, for no apparent reason or in response to own mood; (2) rehearsal to maintain event memory; (3) rehearsal to re-experience emotions; (4) rehearsal in order to reflect on or understand the event; (5) social rehearsal; or (6) cued rehearsal (rehearsal of events in response to environmental cues). Social rehearsal (i.e., social disclosure) was the most frequently cited type of rehearsal, with rehearsal to reflect on the event the least frequent (Walker et al., 2009). Further, these specific types of private rehearsal, or rehearsal with particular goals, have differing consequences for the FAB. Negative emotional intensity is maintained in memory when individuals privately rehearse events with the specific aim of *maintaining event memory*, or when memories come to mind *involuntarily* (Ritchie et al., 2006; Walker et al., 2009). In contrast, when individuals rehearse memories with the aim of *reflecting on the event's meaning,* associated positive affect has been found to increase and associated negative affect to decrease (Ritchie et al., 2006). Although this effect is not always reliable (Walker et al., 2009), it suggests that reflective rehearsal may sometimes be adaptive in terms of the regulation of autobiographical memory.

Neuroticism is associated with rumination (Trapnell & Campbell, 1999) which is defined as *"thinking about one's negative mood and the causes and consequences of that mood"* (Nolen-Hoeksema, 1991). Although rumination is thought to be motivated by a wish

to understand the emotional distress suffered in the past (Nolen-Hoeksema, Wisco, & Lyubomirsky, 2008), repeatedly ruminating upon one's negative mood and event memories is related to worsening negative thinking and affect (Mor & Winquist, 2002), and symptoms of anxiety and depression (Muris, Roelofs, Rassin, Franken, & Mayer, 2005). Whilst rumination refers to a general tendency to repetitively and passively think about past failures, errors, and unpleasant experiences, it seems feasible that a past experienced unpleasant event could be the cause of or a contributor to negative mood, and thus the focus of rumination (Michl, McLaughlin, Shepherd, & Nolen-Hoeksema, 2013).

Pertinently, rumination is proposed to consist of two components: reflection and brooding (Treynor, Gonzalez, & Nolen-Hoeksema, 2003). Reflection represents "purposeful turning inwards to engage in cognitive problem solving" (Treynor et al., 2003, p. 256), which is associated with lower levels of depression in non-clinical samples over short time periods (Takano & Tanno, 2009) and longitudinally (Treynor et al., 2003). Reflection is therefore thought to be a more adaptive subtype of rumination (Joormann et al., 2006). Brooding, on the other hand, is described as a "passive comparison of one's current situation with some unachieved standard" (Treynor et al., 2003, p. 256), and has been associated with higher levels of negative affect (Moberly & Watkins, 2008), and predicts depressive symptoms (Schoofs, Hermans, & Raes, 2010). Previous research suggests that neuroticism is associated with increases in the *brooding* sub-type of rumination, to a greater extent than the reflection sub-type of rumination (Roelofs, Huibers, Peeters, & Arntz, 2008). So, we might expect neuroticism is associated with increased frequency of the rehearsal types that are analogous to, or involved in, brooding but not reflection. For example, neuroticism could be associated with increased frequency of rehearsal to maintain unpleasant event memories so they are not forgotten, rehearsals for no reason, or rehearsals in response to current mood (Barnhofer & Chittka, 2010). Frequency of these types of rehearsal might then be connected to a retention

of negative affect (Ritchie et al., 2006; Walker et al., 2009). In sum, we hypothesesed that an increased frequency of specific *types* of event rehearsal could mediate the effects of neuroticism upon the FAB, as well as or instead of overall private rehearsal of unpleasant events.

Study 2 utilized a similar paradigm as Study 1. Participants completed a measure of neuroticism and recalled three pleasant and three unpleasant event memories and rated each for emotional intensity upon event occurrence and recall. To ensure the effects of neuroticism upon the FAB generalize across differing measurement methods, in Study 2 we utilized a bi-polar scale to collect these emotional intensity ratings (replacing the unipolar scale we used in Study 1). For each event, participants completed a series of ratings examining the extent to which they performed specific forms of private rehearsal. All measures were again completed using an online questionnaire, and the procedure remained equivalent to Study 1 in all other respects.

Method

Participants

One hundred and sixty-eight participants took part in Study 2[ii] (15 males, 153 females) ranging from 18 - 36 years old (M = 18.9 yrs., $S.D.$ = 1.5). Participants were undergraduate and postgraduate university students who received course credit or a small monetary reward for completion of the study. Data was collected in 2014 and no participants who had taken part in Study 1 also contributed to Study 2. Participants were treated in accordance with the ethical guidelines of the British Psychological Society and ethical approval for the study was granted by the appropriate Research Ethics Committee of the university which conducted the research.

Procedure and Measures

Measure of Neuroticism. As in study 1, participants completed Eysenck's Personality Questionnaire Revised - Short Scale (EPQR-S: Eysenck & Eysenck, 1991). Internal consistency of the neuroticism scale was acceptable, $\alpha = .79$, $n = 12$, $M = 6.6$, $SD = 3.2$, and the mean neuroticism score in this participant sample falls within mean estimated neuroticism scores in the general population (Eysenck & Eysenck, 1991).

Event Memory Retrieval. Participants recalled three pleasant and three unpleasant events that they had experienced within the last 12 months, but not within the last seven days. As in study 1, for each event participants provided a title and wrote a brief description of each event. The order of event retrieval was counterbalanced. For each event we additionally collected an estimate of event age (i.e., how long ago the event occurred) in months and days. Although research has shown the FAB cannot be explained on the basis of participants recalling significantly older unpleasant compared to pleasant events (i.e., Ritchie et al., 2009), nonetheless we controlled for event age to ensure it cannot account for the FAB in our samples.

Affect Intensity Ratings and Calculation of Affect Change. For each event participants were asked to rate "*How intense were the emotions you felt when this event originally happened?*" and "*How intense are the emotions you feel when remembering this event now?*", both on a bipolar scale from +3 (*extremely pleasant*) through 0 (*neutral*) to -3 (*extremely unpleasant*). A measure of *affect change* for each event was calculated by subtracting emotional intensity at recall from emotional intensity at occurrence. Due to the bipolar scale used, this necessitated firstly computing the absolute value of the negative ratings, to ensure each event's ratings of affect intensity at occurrence and recall ranged from a positive value (max of 3) to zero. As in study 1, positive values indicated the intensity of emotion decreased from event occurrence to recall, whereas negative values indicated emotion increased in intensity from event occurrence to recall. The size of the value

indicates the extent of change, with greater values indicating greater change in emotional intensity between event occurrence and recall.

Rehearsal Ratings. For each event, participants completed the same rating scale of *overall private rehearsal* as in study 1. In addition to this measure of overall private rehearsal, participants also completed estimates of how frequently they had *privately rehearsed each event for the following six specific reasons* (c.f. Ritchie et al., 2006): (a) for no apparent reason; (b) in response to one's own mood; (c) when reminded to by environmental cues; (d) to reflect on the meaning of the event or to better understand it; (e) so it is not forgotten; (f) to make myself think or feel about myself in a certain way. These ratings were made on a scale from 1 (*not at all*) to 7 (*very frequently*).

Results

Analytic Approach

Although participants were asked to provide three pleasant and three unpleasant events, some participants declined to provide all events, so 970 events were retrieved by participants (490 pleasant, 480 unpleasant). A small percentage of events (11 events, 1.1%) appeared to flip valence from occurrence to recall (e.g., from negative to positive). Given the small percentage of flip affect events, they were removed from the analysis, as is standard practice in FAB studies (e.g., Gibbons et al., 2013; Ritchie, Walker, et al., 2015). A total of 959 events were thus available for analysis.

We took the same analytic approach as in Study 1. We again examined if neuroticism straightforwardly moderated the relationship between event valence and affect change (e.g., the FAB) using model #1 within PROCESS. In other words, we tested for an interaction between event valence (positive vs. negative) and neuroticism (measured continuously) in predicting affect change. We then examined if the effects of neuroticism upon affect change were mediated through overall private rehearsal frequency, using model #4 within PROCESS

for pleasant and unpleasant events separately. We additionally tested if the effects of neuroticism upon affect change were mediated through frequency of each of the six specific rehearsal types, also using model #4 within PROCESS. Finally, in addition to controlling for clustering in the data through a nominal participant variable, we also controlled for event age in each analysis.

Moderation of FAB by Neuroticism

The FAB was again evident, in that there was a main effect of event valence (positive vs. negative) in predicting affect change scores, $b = .71$, se = .12, t (970) = 5.73, $p < .001$, 95% CI [.46, .95]. Unpleasant affect faded in intensity to a greater extent ($M = .95$, $S.D. = .05$) compared to pleasant affect ($M = .42$, $S.D. = .04$.).

There was no main effect of neuroticism in predicting affect change scores, $b = .003$, $se = .01$, t (804) = .29, $p = .76$, 95% CI [-.01, .02]. There was a significant interaction between event valence and neuroticism in predicting affect change, $b = -.04$, $se = .01$, t (970) = -2.61, $p = .009$, 95% CI [-.07, -.01]. Neuroticism did not predict the fading of positive affect, $b = -.01$, t (472) = -.96, $p = .34$, but did predict less fading of negative affect, $b = -.03$, t (464) = 2.17, $p = .03$. Mean affect change scores (see Figure 3) indicate a smaller FAB with increasing neuroticism, due to decreased fading of negative affect.

<Figure 3 here>

Effects of Neuroticism on Affect Change Mediated Through Overall Private Rehearsal Frequency, and Frequency of Specific Rehearsal Types

Overall Private Rehearsal Frequency. Neuroticism did not predict the frequency of overall private rehearsal of pleasant events, $b = -.02$, t (472) = -.99, $p = .32$, 95% CI [-.06, .02], although increasing overall private rehearsal of pleasant events was associated with less fading of positive affect, $b = -.13$, t (472) = -4.29, $p < .001$, 95% CI [-.07, -.19]. There was no

indirect effect of neuroticism on positive affect fading via overall private rehearsal of pleasant events, b = .001, *boot se* = .001*, boot 95% CI* [-.01, .001].

For unpleasant events, with increases in neuroticism scores, there was a corresponding increase in overall private rehearsal of unpleasant events, b = .07, t (464) = 2.99, p = .002, 95% CI [.02, .12]. Further, with increases in frequency of overall private rehearsal of unpleasant events there was a corresponding decrease in the fading of negative affect, b = -.14, t (464) = 5.56, p<.001, 95% CI [-.09, -.20]. The mediation model was supported: with increases in neuroticism scores, there was less fading of negative affect, via increased overall private rehearsal of unpleasant events, b = .01, *boot se* = .004, *boot 95% CI* [.003, .02].

Rehearsal to Reflect on the Event. Study 2 highlighted a mediating role for only one of the six specific types of rehearsal: *rehearsal to reflect on the event*[iii]. Neuroticism did not predict the frequency of rehearsal to reflect on the event for pleasant events, b = -.02, t (487) = -.77, p = .44, 95% CI [.04, .01], although increasing frequency of rehearsal to reflect on pleasant events was associated with less fading of positive affect, b = -.05, t (487) = 2.45, p = .01, 95% CI [.01, .10]. The indirect effect was not significant, b = .001, *boot se* = .001, *boot 95% CI* [-.001, .001].

For unpleasant events however, a similar pattern emerged as for overall private rehearsal. With increases in neuroticism scores, there was a corresponding increase in frequency of rehearsal with the aim of reflection for unpleasant events, b = .07, t (477) = 2.48, p = .01, 95% CI [.01, .13]. Further, with increases in frequency of rehearsal to reflect on unpleasant events, there was a corresponding decrease in the fading of negative affect, b = -.05, t = 2.27, p = .02, 95% CI [.007, .09]. This mediation model was a significant fit to the data, suggesting that neuroticism was associated with an increase in rehearsal to reflect on the

event for unpleasant events, which was in turn linked to less fading of negative affect, *b* = .003, *boot se* = .002, *boot 95% CI* [.0001, .0093].

Discussion of Study 2

There is an appearance of less fading of affect overall for both pleasant and unpleasant events in Study 2 compared to Study 1. This is likely due to the different rating scales used in the two studies. However, notably, the FAB again emerged, this time whilst using a bi-polar scale to collect affect intensity ratings, as opposed to a unipolar scale as used in Study 1. We therefore add to the body of research demonstrating the robustness and reliability of the FAB, as its detection is not tied to type of rating scale used to elicit affect intensity ratings (i.e., Landau & Gunter, 2009).

Neuroticism also moderated the FAB: with increasing neuroticism, negative affect faded less. Further, the effects of neuroticism were mediated via less fading of negative affect in association with an increase in overall private rehearsal of unpleasant events. Notably, we did not replicate the somewhat smaller mediation effect evident in Study 1 around overall private rehearsal of pleasant events. This suggests that the effects of neuroticism upon the FAB are likely to be specific to *unpleasant events* and *negative affect*, as this appears to be more robust and consistent compared to positive affect.

Further, Study 2 clarified that the reduced FAB in association with neuroticism was attributable not to private rehearsal of unpleasant events in general, but to rehearsal with a particular goal: rehearsal with the aim of *reflection*. We note that this bolsters the assumptions made in the FAB literature that participants can determine when and how they have rehearsed event memories with particular goals (e.g., Ritchie et al., 2006; Walker et al., 2009). Our data suggest that the tendency to rehearse memories with a particular goal could be a characteristic feature of a trait such as neuroticism. This initial evidence within the FAB literature of the discriminative validity of different rehearsal types deserves further

investigation in future research, perhaps exploring if other personality traits are associated with characteristic types of event rehearsal.

Our findings that a reduced FAB was associated with reflective rehearsal contrasts with findings in the FAB literature that rehearsal with the aim of reflection can enhance the FAB (Ritchie et al., 2006). It may be that neuroticism influences the nature of reflective rehearsal, making it more akin to brooding, given that neuroticism has been linked to brooding which in turn is linked to higher levels of negative affect (Moberly & Watkins, 2008). Thus, in our final study, we aimed to further explore the mechanism by which neuroticism influences the FAB by directly testing the role of the frequency of rumination, and the subtypes of reflection and brooding.

Study 3

We firstly aimed to replicate the first two studies, in terms of examining the effects of neuroticism on the FAB via the frequency of overall private rehearsal and specific rehearsal types. We also added in measures of the frequency of rumination, and the sub-types of reflection and brooding. Thus, in this study we directly tested if neuroticism's effects upon the FAB are mediated through frequency of rumination, reflection or brooding. Finally, we recruited participants from the general public, thus broadening the scope of the research and ensuring effects generalise beyond student populations.

Method

Participants

One hundred and forty-one participants took part in Study 3 (101 female and 40 male) ranging from 18-76 years old (M = 37.7 yrs., $S.D.$ = 11.9). To increase the generalizability of our findings, participants were recruited from the general UK population using the participant panel website Prolific. Participants were paid a small monetary payment for participating.

Data was collected in 2019, and no participants who took part in the previous two studies also contributed to Study 3. Participants were treated in accordance with the ethical guidelines of the British Psychological Society and ethical approval for the study was granted by the appropriate Research Ethics Committee of the university which conducted the research.

Measure of Neuroticism

Participants again completed Eysenck's Personality Questionnaire Revised - Short Scale (EPQR-S: Eysenck & Eysenck, 1991). Internal consistency of the neuroticism scale was good, $\alpha = .86$, $n = 12$, $M = 7.4$, $SD = 3.5$, and the mean neuroticism score in this participant sample again falls within mean estimated neuroticism scores within the general population (Eysenck & Eysenck, 1991).

Event Memory Retrieval

As in studies 1 and 2, participants recalled three pleasant and three unpleasant events that they had experienced within the last 12 months, but not within the last 7 days. They provided a title, short description of each event, and an estimate of event age (i.e., how long ago the event occurred) in months and days.

Affect Intensity Ratings and Calculation of Affect Change

Participants completed the same bi-polar rating scales as in Study 2 for the collection of affect intensity at event occurrence and at recall. Affect change for each event was calculated as per Study 2.

Rehearsal Ratings

For each event, participants completed the same rating of overall private rehearsal frequency as in studies 1 and 2, and the same ratings as to the frequency of six specific types of rehearsal as in Study 2 (for no apparent reason, in response to one's own mood, when reminded to by environmental cues, to reflect on the meaning of the event or to better understand it, so it is not forgotten, and to make myself think or feel in a certain way). In

addition to these measures, we included measures of the frequency to which participants had performed *brooding and reflective types of rumination* of each event, by adapting items from the Brief State Rumination Inventory (BSRI: Marchetti, Mor, Chiorri, & Koster, 2018) and 10-item Ruminative Responses Scale (RRS: Treynor et al., 2003).

The BSRI taps into maladaptive aspects of rumination, in terms of assessing the extent to which individuals focus their attention on negative thoughts, including causes and implications of distress (Marchetti et al., 2018; Nolen-Hoeksema et al., 2008). Thus, we adapted items from the BSRI (Marchetti et al., 2018) to tap into the frequency to which participants had *brooded* over each event. The BSRI consists of eight items, and we adapted six of these to be relevant to assessing the frequency of brooding over individual events[iv]. For instance, one item originally read "I wonder why I can't respond in a better way" and this was adapted to read "I wonder why I didn't respond to this event in a better way". Participants were asked to rate the following six statements for each event, on a scale from 1 (*not at all)* to 7 (*very frequently*): (a) I reflect on my feelings about this event; (b) I wonder why I reacted the way that I did; (c) I wonder why I felt the way that I did; (d) I rehash what I said or did in this event; (e) I think "why didn't I handle this better?"; (f) I wonder why I didn't respond in a better way. Scores were summed to form a frequency of brooding scale which ranged from 6 to 42, with higher scores representing higher frequency of brooding. The brooding scale showed good internal consistency, $\alpha = .91$, $n = 6$, $M = 16.06$, $SD = 10.01$.

To assess frequency of *reflection*, we adapted the reflection subscale of the 10-item RRS (Treynor et al., 2003) to tap into the frequency to which participants engaged in reflective rumination over each event. The 10 item RRS consists of two subscales that tap into the brooding and reflection elements of rumination. We adapted the five reflection items to relate to reflection over an individual event, and not in general. For instance, one original item from the RRS which read 'I go someplace alone to think about my feelings' was adapted

to refer to reflection in respect to an individual event as follows: 'I go someplace alone to think about my feelings about this event'. Participants rated the following five statements for each event, on a scale from 1 (*not at all*) to 7 (*very frequently*): (a) I analyze this event to understand my feelings about it; (b) I go away by myself and think about why I feel this way about this event; (c) I write down what I am thinking about this event and analyze it; (d) I analyze my personality to try to understand my feelings about this event; (e) I go someplace alone to think about my feelings about this event. Scores were summed to form a frequency of reflective rumination scale which ranged from 5 to 35, with higher scores representing greater frequency of reflective rumination. The reflection scale showed good internal consistency, $\alpha = .88$, $n = 5$, $M = 11.01$, $SD = 7.33$. The scores for both the brooding and reflective rumination scales were summed to form a frequency of *overall rumination* for each event, which ranged from 11 to 77, with higher scores representing greater frequency of overall rumination. The total rumination scale showed good internal consistency, $\alpha = .94$, $n = 11$, $M = 27.04$, $SD = 16.52$.

Results

Analytic Approach

As in Study 2, although participants were asked to provide three pleasant and three unpleasant events, some participants declined to provide all events. Participants retrieved 808 events (412 pleasant and 396 unpleasant). Again, a small percentage of events (4 events, 1%) appeared to flip affect from occurrence to recall (e.g., from negative to positive), and were removed from the analysis, leaving 804 events.

We took the same analytic approach as in the previous two studies. We examined if neuroticism straightforwardly moderated the relationship between event valence and affect change (e.g., the FAB) using model #1 within PROCESS, by testing for an interaction between event valence (positive vs. negative) and neuroticism (measured continuously) upon

affect change scores. We then examined if the effects of neuroticism upon affect change were mediated through overall private rehearsal frequency, or frequency of each of the six specific rehearsal types, using model #4 within PROCESS for pleasant and unpleasant events separately. We additionally tested if the effects of neuroticism upon affect change were mediated through frequency of overall rumination, or frequency of brooding or reflection, also using model #4 within PROCESS. Finally, in addition to controlling for clustering in the data through a nominal participant variable, we also controlled for event age in each analysis.

Moderation of FAB by Neuroticism

The main effect of event valence (positive vs. negative) upon affect change scores was significant, b = .43, t (804) = 2.97, p = .003, 95% CI [.14, .71]. As highlighted in Figure 4, the FAB again emerged, with unpleasant affect fading in intensity to a greater extent (M = .71, *S.D.* = .99) compared to pleasant affect (M = .31, *S.D.* = .80).

The main effect of neuroticism upon affect change scores was not significant, , b = -.007, *se* = .008, t (2746) = -.87, p = .38, 95% CI [-.02, .008], and there was no interaction between neuroticism and event valence in predicting affect change scores, b = -.01, *se* = .01, t (804) = -.88, p = .37, 95% CI [-.04, .01], R^2*change* = *.0009*, F (1, 800) = .78, p = .37.

<Figure 4 here>

Effects of Neuroticism on Affect Change Mediated Through Overall Private Rehearsal Frequency, Frequency of Specific Rehearsal Types, and Frequency of Rumination

Overall Private Rehearsal Frequency. Neuroticism did not predict the frequency of overall private rehearsal of pleasant events, b = .02, t (393) = .96, p = .33, 95% CI [-.02, .07], although with increases in frequency of overall private rehearsal frequency for pleasant events, there was a corresponding decrease in the fading of positive affect, b = -.11, t (393) = -4.98, p<.001, 95% CI [-.16, -.07]. There was no indirect effect of neuroticism on positive

affect fading via overall private rehearsal of pleasant events, *b* = -.002, *boot se* = .003, *boot 95% CI* [-.008, .003].

Consistent with studies 1 and 2, with increases in neuroticism scores, there was a corresponding increase in the frequency of overall private rehearsal of unpleasant events, *b* = .05, *t* (371) = 2.11, *p* = .03, 95% CI [.004, .10]. Further, with increases in frequency of overall private rehearsal of unpleasant events, there was a corresponding decrease in the fading of negative affect, *b* = -.08, *t* (371) = -2.94, *p* = .003, 95% CI [-.13, -.02]. This mediation model was a significant fit to the data, *b* = -.004, *boot se* = .003, *boot 95% CI* [-.01, -.002].

Frequency of Rehearsal to Reflect on the Event. We again found a mediating role for only one of the six specific types of rehearsal: *rehearsal to reflect on the event.* Neuroticism did not predict rehearsal to reflect on the event for pleasant events, *b* = .009, *t* (411) = .35, *p* = .72, 95% CI [-.04, .06], although increases in frequency of rehearsal to reflect on pleasant events was associated with less fading of positive affect, *b* = -.04, *t* (411) = -2.12, *p* = .03, 95% CI [-.08, -.003]. The indirect effect was not significant, *b* = -.0004, *boot se* = .001, *boot 95% CI* [-.003, .002].

The now familiar effect emerged for unpleasant events. With increases in neuroticism scores, there was a corresponding increase in frequency of rehearsal to reflect for unpleasant events, *b* = .06, *t* (393) = 2.17, *p* = .03, 95% CI [.006, .11]. In turn, with increases in the frequency of rehearsal to reflect for unpleasant events, there was a corresponding decrease in the fading of negative affect, *b* = -.05, *t* (393) = -2.15, *p* = .03, 95% CI [-.10, -.004]. This mediation model was a significant fit to the data, *b* = -.003, *boot se* = .002, *boot 95% CI* [-.008, -.001].

Frequency of Reflective Rumination. Study 3 further identified a mediating role for frequency of reflective rumination for unpleasant events (but not for pleasant events; see

footnote[v]). With increases in neuroticism scores, there was a corresponding increase in the frequency of reflective rumination of unpleasant events, b = .08, t (393) = 3.71, p = .002, 95% CI [.04, .13]. In turn, with increases in the frequency of reflective rumination of unpleasant events, there was a corresponding decrease in the fading of negative affect, b = -.11, t (393) = -3.84, p = .001, 95% CI [-.17, -.05]. The mediation model was a significant fit to the data, b = -.01, *boot se* = .004, *boot 95% CI* [-.01, -.003].

Discussion of Study 3

Study 3 replicated many of the effects seen in the first two studies: frequency of overall private rehearsal of unpleasant events mediated the effects of neuroticism on the FAB, as did frequency of rehearsal with the aim of reflecting for unpleasant events. Notably, these results generalized from the primarily student samples in Studies 1 and 2, to the general population sample in Study 3. Interestingly, we did not find any relationship between neuroticism and frequency of brooding, in contrast to previous research which suggests that neuroticism is particularly linked to the brooding sub-type of rumination (Roelofs et al., 2008). In contrast, Study 3 highlighted that the effects of neuroticism upon affect change were mediated through the frequency of the *reflective* subtype of rumination. With increasing neuroticism, frequency of reflective rumination over unpleasant events increased, and in turn negative affect was retained.

General Discussion

As expected, across all three studies, the Fading affect bias emerged: negative affect associated with unpleasant events faded in autobiographical memory to a greater extent compared to positive affect associated with pleasant events. Thus, we add to the now extensive body of literature finding evidence of the FAB (Gibbons et al., 2016; Gibbons et al., 2015; Gibbons et al., 2017; Gibbons et al., 2011; Gibbons et al., 2013; Ritchie, Batteson,

et al., 2015; Ritchie, Walker, et al., 2015). Across all three studies, the effects of neuroticism upon negative affect were mediated via frequency of overall private rehearsal of unpleasant events. With increasing neuroticism, there was an increase in overall private rehearsal of unpleasant events, which was linked to less fading of negative affect. In studies two and three, we further found this effect to be specific to rehearsal with the goal to reflect on the event: with increasing neuroticism, there was a corresponding increase in frequency in reflective rehearsal of unpleasant events, which was in turn linked to less fading of negative affect. Finally, in our final study we found a mediating role for the reflective sub-type of rumination. With increasing neuroticism, there was a corresponding increase in reflective rumination over unpleasant events, which was in turn linked to less fading of affect. Therefore, for the first time in the FAB literature we show that neuroticism, an individual difference linked to emotional regulation, impacts on the FAB via the tendency to engage in reflective rumination over previously experienced unpleasant events.

Moderation of the FAB by neuroticism

We found that the moderation effect of neuroticism upon the FAB (i.e., an interaction between event valence and neuroticism scores upon affect change) was inconsistent, emerging only in study 2, but not studies 1 and 3. We are not alone in an observation like this. Walker et al. (2003) only found a significant interaction between event valence and depression in one of the replications reported in their second study (although a general pattern across studies did emerge), and Gibbons and Lee (2019) reported a significant effect of depression upon the FAB when combining data from studies to create a large sample of participants and events. Following this approach, we converted the affect change scores into standardized scores, then used these scores in a combined analysis across all three studies. We examined if the event valence *x* neuroticism interaction emerged with a greater sample of participants ($n = 483$) and events ($n = 2746$). This was indeed the case[vi]. This immediately

suggests that the issue was one of low power in attempting to detect the small effect of the event valence *x* neuroticism interaction. We suggest that future researchers seeking to explore individual differences in relation to the FAB aim to recruit a substantial number of participants; the results of our combined analysis suggest that a participant sample size of approximately 400 might be sufficient to detect small effect sizes such as we observed here.

Using this combined approach, neuroticism was associated with a smaller FAB, due to decreased fading of negative affect (but there were no effects of neuroticism upon positive affect fading). This is in line with the conceptualization of neuroticism as being an individual difference associated in the main with experience of *negative affect* (Gross et al., 1998) and with deficits in ability to effectively regulate *negative emotions* (W. Ng & Diener, 2009). This also provides further convergent evidence that the FAB emerges as a result of emotional regulation processes operating on autobiographical memory (Walker & Skowronski, 2009): where there are deficits in emotional regulation ability, the FAB is reduced. We now demonstrate this is the case for neuroticism, and it manifested in a smaller FAB due to less fading of negative affect.

The consistent effects of neuroticism upon negative affect, but inconsistent effects of neuroticism upon positive affect, are similar to observations made in respect to the FAB in depression and anxiety. Previous research has found fairly consistently less fading of negative affect in association with depression (Gibbons & Lee, 2019; Walker et al., 2003) and anxiety (Gibbons & Lee, 2019; Walker et al., 2014; but see Marsh et al., 2019), but effects of these psychological distress variables upon positive affect fading has been less consistent. Walker et al. (2003) found more fading of positive affect in association with depression, as did Gibbons and Lee (2019) when they combined data from several studies. However, these effects have not always been replicated. Depression has also been linked to *less* fading of positive affect (Marsh et al., 2019), as has anxiety (Walker et al., 2014), whilst

another study reported that anxiety was *unrelated* to positive affect fading (Marsh et al., 2019). Thus, psychological variables that are related to emotional regulation seem to more consistently impact on the FAB via less fading of negative affect, whilst effects upon positive fading are far less consistent. This has been observed in relation to depression and anxiety, and we now demonstrate similar effects with neuroticism. Potentially, the inconsistencies in relation to positive affect in the FAB could relate to individual differences in abilities to use emotional regulation strategies. Adaptive emotional regulation includes strategies which downregulate negative emotions but also upregulate positive emotions, and individuals can vary in their use of these different types of strategies (Gross, 1998b). The extent to which the FAB is influenced by psychological variables such as depression, anxiety and neuroticism may depend on individual differences in ability to use these strategies, with positive affect being particularly impacted on by strategies that upregulate positive affect, such as savoring (Bryant, 2003). Although beyond the scope of the current paper, future research could investigate the inconsistencies with respect to positive affect further, by measuring or manipulating use of a variety of emotional regulation strategies by participants.

Reflective rumination, neuroticism, and the FAB

We add to the body of FAB research pointing to rehearsal as an important cognitive mechanism underlying the development of the FAB. Rehearsal has been consistently implicated in the FAB in studies examining its role as a direct moderator (Ritchie et al., 2006), and as a mediator of complex interactions with individual differences and event types in the FAB (Gibbons et al., 2016; Gibbons et al., 2017). We further show that rehearsal frequency of unpleasant events mediated the effects of neuroticism on negative affect fading. Evidence is therefore mounting that the FAB occurs, at least partly, as a result of cognitive work involved when events are rehearsed. The FAB is propsed to exist as a result of healthy coping mechanisms operating on autobiograhical memory (Walker & Skowronski, 2009), and

rehearsal appears to be one of those healthy coping mechanisms. However, our research (and others, such as Ritchie et al., 2006) suggests that the *nature* of such rehearsal is an important predictor of whether rehearsal is indeed adaptive, leading to the FAB, or maladaptive, leading to a reduced FAB.

Concerning the nature of rehearsal and its implications for FAB, we found that neuroticism was associated with reflective rumination, which was in turn linked to a reduced FAB in terms of less fading of negative affect. This suggests that reflective rumination can be maladaptive, in terms of its effects upon negative affect fading. This interpretation is rooted in the FAB literature, which assumes that a reduced or disrupted FAB is indicative of a disruption to the self-protective processes in autobiographical memory which act to protect the self from being overwhelmed by negative emotions (Walker & Skowronski, 2009). Thus, the reduced FAB which has been observed with sub-clinical levels of depression/dysphoria (Walker et al., 2003) and anxiety (Walker et al., 2014) is assumed to represent an undesirable outcome. Indeed, some research suggests that reflective rumination can be associated with negative outcomes. For example, reflective rumination can be positively correlated with depression (Rude, Little Maestas, & Neff, 2007), and also longitudinally predicts depression (Miranda & Nolen-Hoeksema, 2007). In line with this research, our results could suggest that reflective rumination is a maladaptive emotional regulation strategy for individuals with high levels of neuroticism, as it is linked to less fading of negative affect, which could then act as a risk factor for the later development of dysphoria or depressive symptoms (e.g., Marsh et al., 2019).

However, there is an alternative account for our results[vii]. Reflective rumination has also been shown to be adaptive, or at least not maladaptive in comparison to the brooding sub-type of rumination. For instance, reflective rumination has been related to adaptive coping strategies in adolescents, such as problem solving, emotional regulation, acceptance,

and positive thinking (Burwell & Shirk, 2007). Further, there is evidence that although reflective pondering (theoretically equivalent to reflective rumination) is immediately associated with *greater* depressive symptoms, it is also associated with *fewer* depressive symptoms in the longer term (Treynor et al., 2003). Thus, Nolen-Hoeksema et al. (2008) suggest that although reflective rumination can sometimes be linked to greater depressive symptoms and negative affect, in the longer term might also lead to a reduction of negative affect due to an increase in adaptive coping strategies, such as problem solving.

Thus, an alternative interpretation of our results is that the link between reflective rumination over past experienced unpleasant events, and the retention of negative affect, is indicative of a process by which individuals with high levels of neuroticism purposefully review and reflect upon past unpleasant events and negative emotions. Longitudinally, this could be linked to an eventual reduction in negative affect, as was observed with reflective pondering in individuals with depressive symptoms (Treynor et al., 2003). These two different interpretations of our data are interesting, but we also acknowledge that it is beyond the scope of the paper to fully understand which interpretation is more likely. In particular, because we did not collect any clinical outcomes such as anxiety, depression, or other wellbeing outcomes, we cannot fully speak to them. We encourage future research to employ a longitudinal measurement of negative affect, along with wellbeing outcomes, in individuals with neuroticism who engage in reflective rumination to tease apart these two interpretations.

Possibly, it could be that neuroticism influences the *nature* of reflective rumination. Both reflection and brooding are types of self-focus, and self-focus can take two forms: experiential versus analytical (Watkins, 2004). Experiential self-focus involves processing experiences in the present moment, in a non-evaluative, and non-judgmental way. Analytical self-focus on the other hand, is abstract, associated with reduced problem solving, and involves self-evaluation (Watkins & Teasdale, 2004). Notably, if the evaluation element of

analytical self-focus is negative in nature, in terms of evaluating the self negatively, this can be maladaptive. Even though individuals usually engage in reflective rumination to understand meanings and consider implications of unpleasant events, if this is done through a negative evaluative lens it will not necessarily be an adaptive process. Potentially, the predisposition to experience negative affect which is associated with neuroticism (Gross et al., 1998) might make such negative self-evaluation more likely during episodes of reflective rumination, which could then lead to the retention of negative affect. Exploring this possibility further forms an interesting avenue for future research attention and may provide additional explanatory information as to the nature of the relationship between neuroticism and reflective rumination.

Our studies had some limitations that we must acknowledge, along with suggestions for future research directions. We firstly caution that our results are not definitive evidence of mediation of the effects of neuroticism on the FAB via rehearsal or rumination; all the variables in this study were measured and not manipulated,and so the emergence of moderation and mediation effects in our analyses only suggest that such models fit the data (Spencer, Zanna, & Fong, 2005). Thus, in order to demonstrate causal effects, we urge researchers in this area to broaden the methods used. We used a retrospective recall paradigm in which participants self-reported frequency of rehearsal using single-item measures, which is a typical approach in this research area (Gibbons & Bouldin, 2019; Gibbons et al., 2017). Whilst this approach allows plausible associations to be established between individual difference measures, cognitive strategies and FAB, future research should build upon the robustness of these findings. Firstly, resarchers should move beyond single-item measures of rehearsal frequency by developing and validating multiple-item scales of rehearsal. Further, researchers in this area have begun to use experimental methods to explore causal mechanisms underlying the FAB (Muir, Brown, & Madill, 2015; Skowronski et al., 2004),

and we encourage future research to expand this experimental work to better understand the causal relationship between individual differences, cognitive and social mechanisms, and the FAB. For instance, an interesting future direction could also involve a manipulation of the nature of reflective rehearsal, to bolster our speculations about negative self-focus during reflective rumination in relation to the retention of negative affect. Further, to extend the robustness of findings, future research would also do well to use alternative methods of collecting events for inclusion, such as experience sampling or daily diary studies. Finally, across all three studies, our samples were biased towards a majority of female participants. This is pertinent given that rumination, both brooding and reflection subtypes, have been observed more in females than male participants (Johnson & Whisman, 2013). Therefore, we encourage researchers to replicate and explore our effects using a study design which ensures a random selection of events, along with a diverse and balanced participant sample. This would work towards ensuring an unbiased dataset to increase the validity of results.

In conclusion, across three studies we investigated how neuroticism acts to influence a universal phenomenon of autobiographical memory, the differential fading of positive versus negative affect associated with everyday events. We provide new insights into the unique relationship between neuroticism, private rehearsal and rumination, and autobiographical memory. We also highlight that neuroticism can influence the impact that reflective rumination has on affective memory; whether the associated retention of negative affect in memory linked with reflective rumination represents a maladaptive or adaptive emotional process remains an interesting puzzle for future researchers to solve.

References

Barnhofer, T., & Chittka, T. (2010). Cognitive reactivity mediates the relationship between neuroticism and depression. *Behav Res Ther, 48*(4), 275-281. doi:10.1016/j.brat.2009.12.005

Bolger, N., & Schilling, E. (1991). Personality and the Problems of Everyday Life: The Role of Neuroticism In Exposure and Reactivity to Daily Stressors. *Journal of personality, 59*, 355-386. doi:10.1111/j.1467-6494.1991.tb00253.x

Bryant, F. B. (2003). Savoring beliefs inventory (SBI): A scale for measuring beliefs about savouring. *Journal of Mental Health, 12*, 175-196. doi:10.1080/0963823031000103489

Burwell, R. A., & Shirk, S. R. (2007). Subtypes of Rumination in Adolescence: Associations Between Brooding, Reflection, Depressive Symptoms, and Coping. *Journal of Clinical Child and Adolescent Psychology, 36*(1), 56-65. doi:10.1207/s15374424jccp3601_6

Cisler, J. M., Olatunji, B. O., Feldner, M. T., & Forsyth, J. P. (2010). Emotion Regulation and the Anxiety Disorders: An Integrative Review. *Journal of Psychopathology and Behavioral Assessment, 32*(1), 68-82. doi:10.1007/s10862-009-9161-1

Costa Jr, P. T., & McCrae, R. R. (1992). Four ways five factors are basic. *Personality and Individual Differences, 13*(6), 653-665.

Denkova, E., Dolcos, S., & Dolcos, F. (2012). Reliving emotional personal memories: affective biases linked to personality and sex-related differences. *Emotion, 12*(3), 515-528. doi:10.1037/a0026809

Eysenck, H. J., & Eysenck, S. B. G. (1991). *Manual of the Eysenck personality scales (EPS adult) : comprising the EPQ-revised (EPQ-R) (including addiction and criminality scales), EPQ-R short scale, impulsiveness (IVE) questionnaire (implsiveness/ venturesomeness/empathy)*. London, UK: Hodder & Stoughton.

Gibbons, J. A., & Bouldin, B. (2019). Videogame play and events are related to unhealthy emotion regulation in the form of low fading affect bias in autobiographical memory. *Consciousness and Cognition, 74*, 102778. doi:https://doi.org/10.1016/j.concog.2019.102778

Gibbons, J. A., Fehr, A. M. A., Brantley, J. C., Wilson, K. J., Lee, S. A., & Walker, W. R. (2016). Testing the fading affect bias for healthy coping in the context of death. *Death Studies, 40*(8), 513-527. doi:10.1080/07481187.2016.1186760

Gibbons, J. A., Hartzler, J. K., Hartzler, A. W., Lee, S. A., & Walker, W. R. (2015). The Fading affect bias shows healthy coping at the general level, but not the specific level for religious variables across religious and non-religious events. *Consciousness and Cognition: An International Journal, 36*, 265-276. doi:10.1016/j.concog.2015.07.004

Gibbons, J. A., Horowitz, K. A., & Dunlap, S. M. (2017). The fading affect bias shows positive outcomes at the general but not the individual level of analysis in the context of social media. *Consciousness and Cognition: An International Journal, 53*, 47-60. doi:10.1016/j.concog.2017.05.009

Gibbons, J. A., & Lee, S. A. (2019). Rehearsal partially mediates the negative relations of the fading affect bias with depression, anxiety, and stress. *Applied Cognitive Psychology, 33*(4), 693-701. doi:https://doi.org/10.1002/acp.3538

Gibbons, J. A., Lee, S. A., & Walker, W. R. (2011). The fading affect bias begins within 12 hours and persists for 3 months. *Applied Cognitive Psychology, 25*(4), 663-672. doi:10.1002/acp.1738

Gibbons, J. A., Toscano, A., Kofron, S., Rothwell, C., Lee, S. A., Ritchie, T. D., & Walker, W. R. (2013). The fading affect bias across alcohol consumption frequency for alcohol-related and non-alcohol-related events. *Consciousness and Cognition: An International Journal, 22*(4), 1340-1351. doi:10.1016/j.concog.2013.09.004

Gross, J. J. (1998a). Antecedent-and response-focused emotion regulation: divergent consequences for experience, expression, and physiology. *J Pers Soc Psychol, 74*(1), 224.

Gross, J. J. (1998b). The emerging field of emotion regulation: An integrative review. *Review of general psychology, 2*(3), 271-299.

Gross, J. J., Sutton, S. K., & Ketelaar, T. (1998). Relations between Affect and Personality: Support for the Affect-Level and Affective-Reactivity Views. *Personality and Social Psychology Bulletin, 24*(3), 279-288. doi:10.1177/0146167298243005

Haga, S. M., Kraft, P., & Corby, E.-K. (2009). Emotion regulation: Antecedents and well-being outcomes of cognitive reappraisal and expressive suppression in cross-cultural samples. *Journal of happiness studies, 10*(3), 271-291.

Johnson, D. P., & Whisman, M. A. (2013). Gender differences in rumination: A meta-analysis. *Personality and Individual Differences, 55*(4), 367-374.

Joormann, J., Dkane, M., & Gotlib, I. H. (2006). Adaptive and maladaptive components of rumination? Diagnostic specificity and relation to depressive biases. *Behav Ther, 37*(3), 269-280. doi:10.1016/j.beth.2006.01.002

Joormann, J., & Gotlib, I. H. (2010). Emotion regulation in depression: relation to cognitive inhibition. *Cognition & emotion, 24*(2), 281-298. doi:10.1080/02699930903407948

Lahey, B. B. (2009). Public health significance of neuroticism. *American Psychologist, 64*(4), 241-256. doi:10.1037/a0015309

Landau, J. D., & Gunter, B. C. (2009). 'Don't worry; you really will get over it': Methodological investigations of the fading affect bias. *The American Journal of Psychology, 122*(2), 209-217.

Levine, L. J., & Bluck, S. (2004). How Emotions Fade: Valence, Appraisals, and the Emotional Impact of Remembered Events. In *Advances in Psychology Research, Volume 30.* (pp. 3-20). Hauppauge, NY, US: Nova Science Publishers.

Marchetti, I., Mor, N., Chiorri, C., & Koster, E. H. W. (2018). The Brief State Rumination Inventory (BSRI): Validation and psychometric evaluation. *Cognitive Therapy and Research, 42*(4), 447-460. doi:10.1007/s10608-018-9901-1

Marsh, C., Hammond, M. D., & Crawford, M. T. (2019). Thinking about negative life events as a mediator between depression and fading affect bias. *PLoS ONE, 14*(1).

McCrae, R. R., & Costa Jr, P. T. (2013). Introduction to the empirical and theoretical status of the five-factor model of personality traits. In *Personality disorders and the five-factor model of personality, 3rd ed.* (pp. 15-27). Washington, DC, US: American Psychological Association.

Michl, L. C., McLaughlin, K. A., Shepherd, K., & Nolen-Hoeksema, S. (2013). Rumination as a mechanism linking stressful life events to symptoms of depression and anxiety: longitudinal evidence in early adolescents and adults. *J Abnorm Psychol, 122*(2), 339-352. doi:10.1037/a0031994

Mineka, S., Watson, D., & Clark, L. A. (1998). Comorbidity of anxiety and unipolar mood disorders. *Annual Review of Psychology, 49*, 377-412.

Miranda, R., & Nolen-Hoeksema, S. (2007). Brooding and reflection: rumination predicts suicidal ideation at 1-year follow-up in a community sample. *Behav Res Ther, 45*(12), 3088-3095. doi:10.1016/j.brat.2007.07.015

Moberly, N. J., & Watkins, E. R. (2008). Ruminative self-focus and negative affect: an experience sampling study. *J Abnorm Psychol, 117*(2), 314-323. doi:10.1037/0021-843X.117.2.314

Mor, N., & Winquist, J. (2002). Self-focused attention and negative affect: a meta-analysis. *Psychol Bull, 128*(4), 638-662. doi:10.1037/0033-2909.128.4.638

Muir, K., Brown, C., & Madill, A. (2015). The fading affect bias: Effects of social disclosure to an interactive versus non-responsive listener. *Memory, 23*(6), 829-847. doi:10.1080/09658211.2014.931435

Muris, P., Roelofs, J., Rassin, E., Franken, I., & Mayer, B. (2005). Mediating effects of rumination and worry on the links between neuroticism, anxiety and depression. *Personality and Individual Differences, 39*(6), 1105-1111. doi:https://doi.org/10.1016/j.paid.2005.04.005

Ng, F., Trauer, T., Dodd, S., Callaly, T., Campbell, S., & Berk, M. (2007). The validity of the 21-item version of the Depression Anxiety Stress Scales as a routine clinical outcome measure. *Acta Neuropsychiatr, 19*(5), 304-310. doi:10.1111/j.1601-5215.2007.00217.x

Ng, W., & Diener, E. (2009). Feeling bad? The 'power' of positive thinking may not apply to everyone. *Journal of Research in Personality, 43*(3), 455-463. doi:10.1016/j.jrp.2009.01.020

Nolen-Hoeksema, S. (1991). Responses to depression and their effects on the duration of depressive episodes. *J Abnorm Psychol, 100*(4), 569-582. doi:10.1037/0021-843X.100.4.569

Nolen-Hoeksema, S., Wisco, B. E., & Lyubomirsky, S. (2008). Rethinking rumination. *Perspectives on psychological science, 3*(5), 400-424.

Paulus, D. J., Vanwoerden, S., Norton, P. J., & Sharp, C. (2016). From neuroticism to anxiety: Examining unique contributions of three transdiagnostic vulnerability factors. *Personality and Individual Differences, 94*, 38-43. doi:10.1016/j.paid.2016.01.012

Rasmussen, A. S., & Berntsen, D. (2010). Personality traits and autobiographical memory: Openness is positively related to the experience and usage of recollections. *Memory, 18*(7), 774-786. doi:10.1080/09658211.2010.514270

Ritchie, T. D., Batteson, T. J., Bohn, A., Crawford, M. T., Ferguson, G. V., Schrauf, R. W., . . . Walker, W. R. (2015). A pancultural perspective on the fading affect bias in autobiographical memory. *Memory, 23*(2), 278-290. doi:10.1080/09658211.2014.884138

Ritchie, T. D., Kitsch, K. S., Dromey, M., & Skowronski, J. J. (2018). Individuals who report eating disorder symptoms also exhibit a disrupted fading affect bias in autobiographical memory. *Memory*. doi:10.1080/09658211.2018.1502321

Ritchie, T. D., Skowronski, J. J., Hartnett, J., Wells, B., & Walker, W. R. (2009). The fading affect bias in the context of emotion activation level, mood, and personal theories of emotion change. *Memory, 17*(4), 428-444. doi:10.1080/09658210902791665

Ritchie, T. D., Skowronski, J. J., Wood, S. E., Walker, W. R., Vogl, R. J., & Gibbons, J. A. (2006). Event Self-importance, Event Rehearsal, and the Fading affect bias in Autobiographical Memory. *Self and Identity, 5*(2), 172-195. doi:10.1080/15298860600591222

Ritchie, T. D., Walker, W. R., Marsh, S., Hart, C., & Skowronski, J. J. (2015). Narcissism distorts the fading affect bias in autobiographical memory. *Applied Cognitive Psychology, 29*(1), 104-114. doi:10.1002/acp.3082

Roelofs, J., Huibers, M., Peeters, F., & Arntz, A. (2008). Effects of neuroticism on depression and anxiety: Rumination as a possible mediator. *Personality and Individual Differences, 44*(3), 576-586. doi:https://doi.org/10.1016/j.paid.2007.09.019

Rubin, D. C., & Siegler, I. C. (2004). Facets of personality and the phenomenology of autobiographical memory. *Applied Cognitive Psychology, 18*(7), 913-930. doi:10.1002/acp.1038

Rude, S. S., Little Maestas, K., & Neff, K. (2007). Paying attention to distress: What's wrong with rumination? *Cognition and Emotion, 21*(4), 843-864. doi:10.1080/02699930601056732

Schoofs, H., Hermans, D., & Raes, F. (2010). Brooding and Reflection as Subtypes of Rumination: Evidence from Confirmatory Factor Analysis in Nonclinical Samples using the Dutch Ruminative Response Scale. *Journal of Psychopathology and Behavioral Assessment, 32*(4), 609-617. doi:10.1007/s10862-010-9182-9

Skowronski, J. J., Gibbons, J. A., Vogl, R. J., & Walker, W. R. (2004). The effect of social disclosure on the intensity of affect provoked by autobiographical memories. *Self and Identity, 3*(4), 285-309. doi:10.1080/13576500444000065

Skowronski, J. J., & Walker, W. R. (2004). How describing autobiographical events can affect autobiographical memories. *Social Cognition, 22*(5), 555-590. doi:10.1521/soco.22.5.555.50764

Spencer, S. J., Zanna, M. P., & Fong, G. T. (2005). Establishing a causal chain: why experiments are often more effective than mediational analyses in examining psychological processes. *J Pers Soc Psychol, 89*(6), 845.

Takano, K., & Tanno, Y. (2009). Self-rumination, self-reflection, and depression: self-rumination counteracts the adaptive effect of self-reflection. *Behav Res Ther, 47*(3), 260-264. doi:10.1016/j.brat.2008.12.008

Trapnell, P. D., & Campbell, J. D. (1999). Private self-consciousness and the five-factor model of personality: distinguishing rumination from reflection. *J Pers Soc Psychol, 76*(2), 284-304. doi:10.1037//0022-3514.76.2.284

Treynor, W., Gonzalez, R., & Nolen-Hoeksema, S. (2003). Rumination Reconsidered: A Psychometric Analysis. *Cognitive Therapy and Research, 27*(3), 247-259. doi:10.1023/A:1023910315561

Walker, W. R., & Skowronski, J. J. (2009). The fading affect bias: But what the hell is it for? *Applied Cognitive Psychology, 23*(8), 1122-1136. doi:10.1002/acp.1614

Walker, W. R., Skowronski, J. J., Gibbons, J. A., Vogl, R. J., & Ritchie, T. D. (2009). Why people rehearse their memories: frequency of use and relations to the intensity of emotions associated with autobiographical memories. *Memory, 17*(7), 760-773. doi:10.1080/09658210903107846

Walker, W. R., Skowronski, J. J., Gibbons, J. A., Vogl, R. J., & Thompson, C. P. (2003). On the emotions that accompany autobiographical memories: Dysphoria disrupts the fading affect bias. *Cognition and Emotion, 17*(5), 703-723. doi:10.1080/02699930302287

Walker, W. R., Yancu, C. N., & Skowronski, J. J. (2014). Trait anxiety reduces affective fading for both positive and negative autobiographical memories. *Advances in Cognitive Psychology, 10*(3), 81-89. doi:10.5709/acp-0159-0

Watkins, E. (2004). Adaptive and maladaptive ruminative self-focus during emotional processing. *Behav Res Ther, 42*(9), 1037-1052. doi:10.1016/j.brat.2004.01.009

Watkins, E., & Teasdale, J. D. (2004). Adaptive and maladaptive self-focus in depression. *J Affect Disord, 82*(1), 1-8. doi:10.1016/j.jad.2003.10.006

Watson, D., & Clark, L. A. (1984). Negative affectivity: The disposition to experience aversive emotional states. *Psychological Bulletin, 96*(3), 465-490. doi:10.1037/0033-2909.96.3.465

Yang, J., Mao, Y., Niu, Y., Wei, D., Wang, X., & Qiu, J. (2020). Individual differences in neuroticism personality trait in emotion regulation. *J Affect Disord, 265*, 468-474. doi:https://doi.org/10.1016/j.jad.2020.01.086

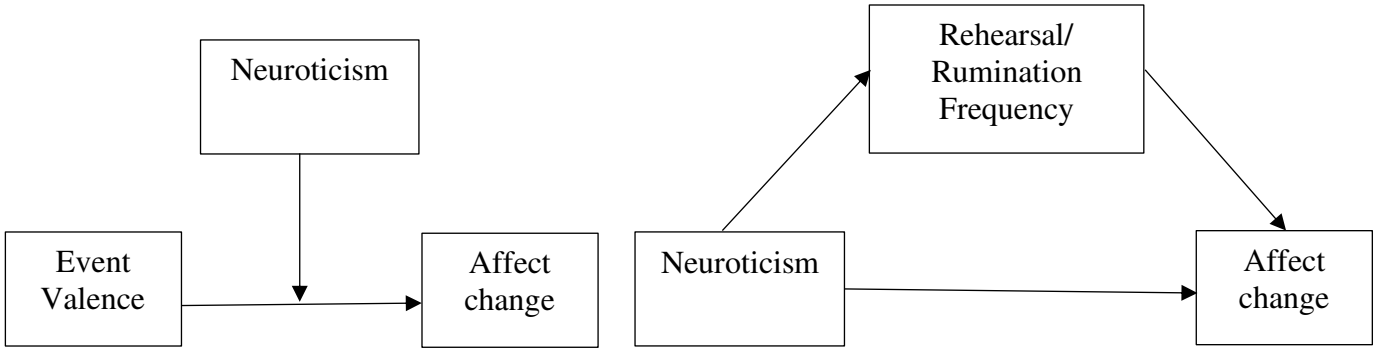

Figure 1.

Models tested in Studies 1, 2, and 3: Moderation of Affect Change by Neuroticism (*left*) and Effects of Neuroticism upon Affect Change Mediated Through Rehearsal or Rumination Frequency (*right*)

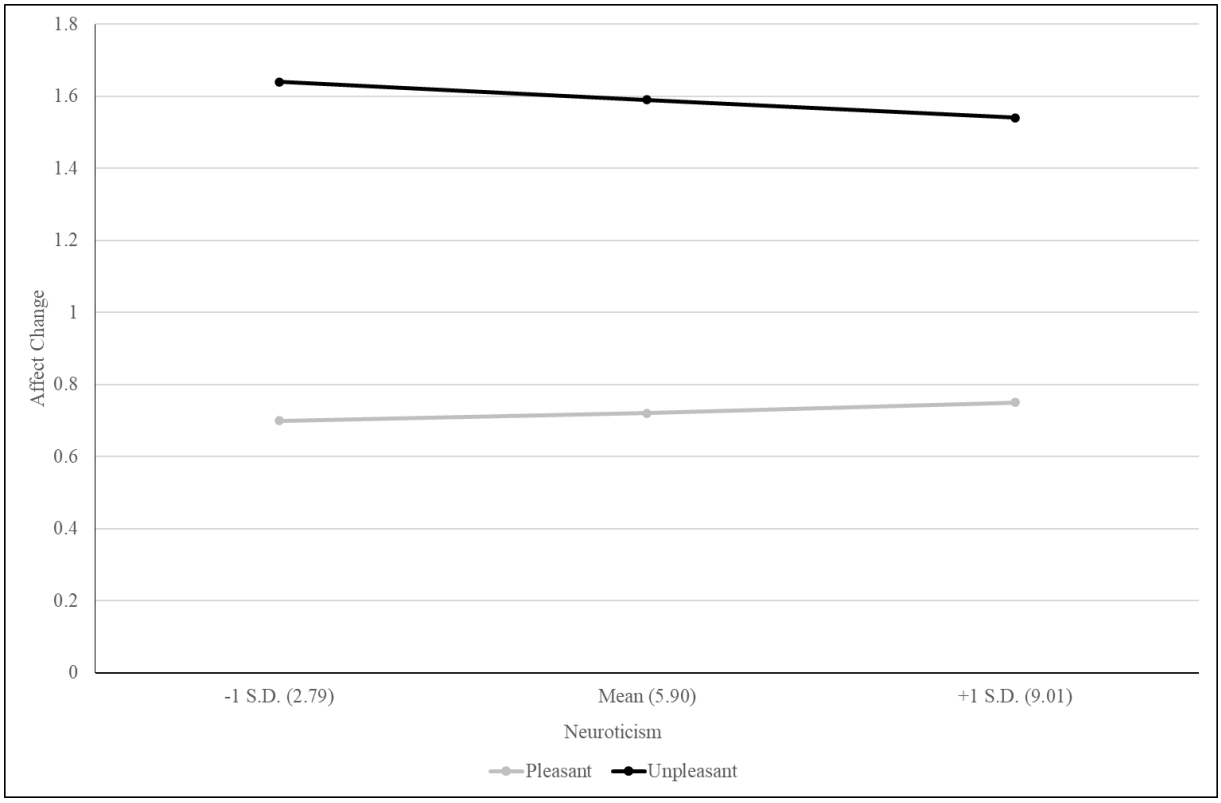

Figure 2.

Mean Affect Change Scores for Pleasant and Unpleasant Events in Relation to Levels of Neuroticism (-1 SD, mean, +1 SD) in Study 1. Positive values indicate the intensity of emotion decreased from event occurrence to recall and negative values indicate emotion increased in intensity. Greater values indicate greater change in emotional intensity.

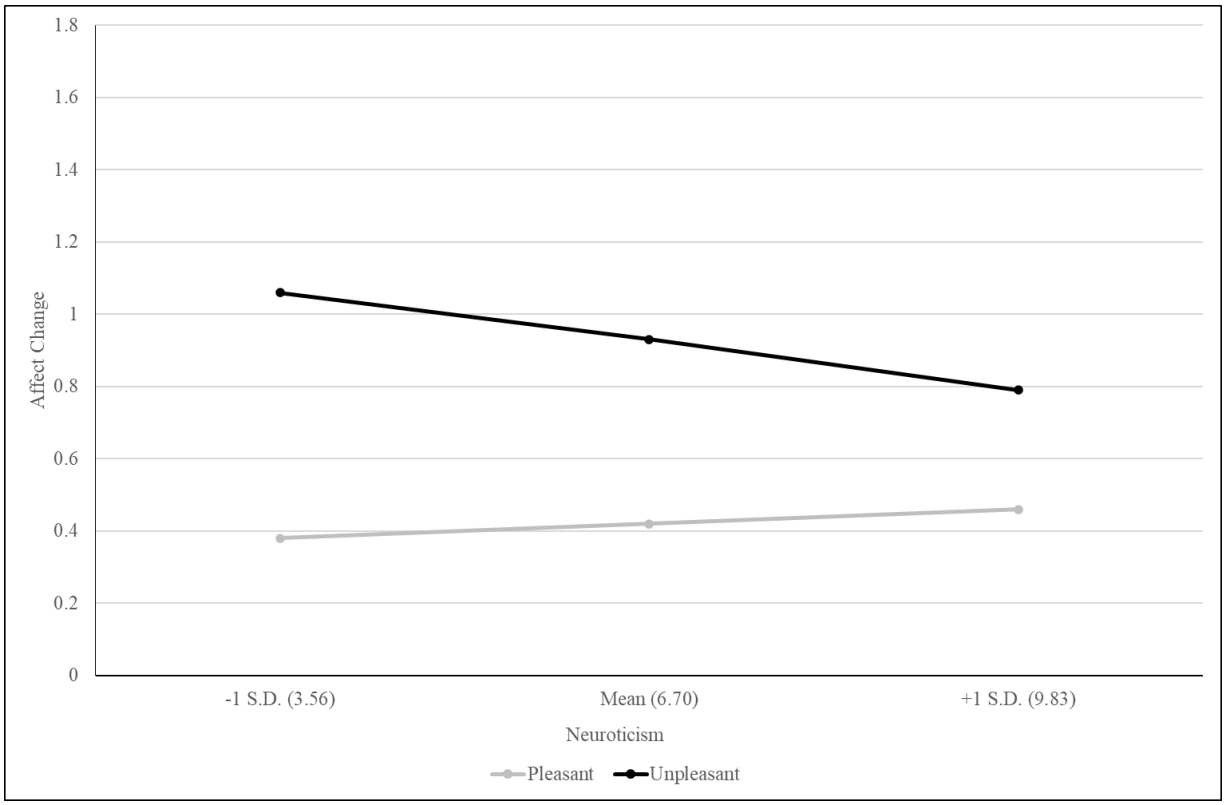

Figure 3.

Mean Affect Change Scores for Pleasant and Unpleasant Events in Relation to Levels of Neuroticism (-1 SD, mean, +1 SD) in Study 2. Positive values indicate the intensity of emotion decreased from event occurrence to recall and negative values indicate emotion increased in intensity. Greater values indicate greater change in emotional intensity.

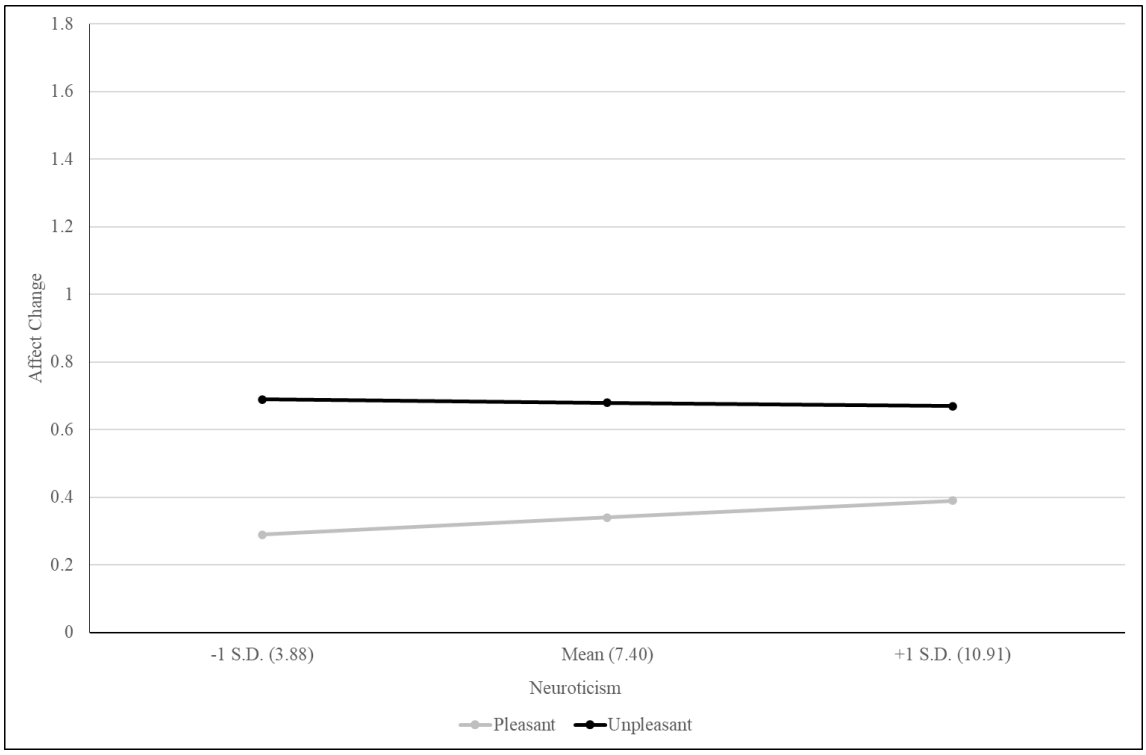

Figure 4.

Mean Affect Change Scores for Pleasant and Unpleasant Events in Relation to Levels of Neuroticism (-1 SD, mean, +1 SD) in Study 3. Positive values indicate the intensity of emotion decreased from event occurrence to recall and negative values indicate emotion increased in intensity. Greater values indicate greater change in emotional intensity.

[i] We were unable to calculate internal consistency for the neuroticism measure in study 1, as the measure was originally collected via pen and paper questionnaires which were manually summed to calculate the overall neuroticism score, and individual responses for each item were not retained. However, we note that internal consistency for the neuroticism measure was satisfactory in studies 2 and 3.

[ii] Note, there is a small overlap here with data presented in ([citation removed for peer review]). Data from the present sample of participants forms a subset of the sample reported in that paper. However, here we present new data and analyses pertaining to neuroticism and rehearsal that did not appear in our previous paper.

[iii] We conducted our analyses on all the different rehearsal types. However, neuroticism scores only predicted the frequency of rehearsal to reflect on the event, whilst neuroticism did not predict the frequency of any of the other rehearsal types. For clarity and brevity, we only report significant results here. The same applies to study 3.

[iv] We felt the remaining two items in the BSRI could not be amended appropriately to refer to individual events, so we did not include them in our measure of brooding: 'I am thinking: Why do I have problems other people don't have?' and 'It is hard for me to shut off negative thoughts about myself'.

[v] All effects for pleasant events were non-significant, as were all effects involving overall rumination and brooding: Neuroticism did not predict frequency of overall rumination of pleasant events, b = .05, t(411) = .86, p = .38, 95% CI [-.07, .19], or frequency of brooding of pleasant events, b = .04, t (411) = 1.22, p = .22, 95% CI [-.02, .12] or frequency of reflective rumination of pleasant events, b = .03, t (411) = 1.28, p = .19, 95% CI [-.01, .09]. Frequency of overall rumination did not predict fading of pleasant affect, b = -.006, t (411) = -.76, p = .44, 95% CI [-.02, .009], and nor did frequency of brooding, b = -.01, t (411) = -.78, p = .43, 95% CI [-.03, .01], or frequency of reflective rumination, b = -.02, t (411) = -1.14, p = .25, 95% CI [-.06, .01]. Neuroticism did predict greater frequency of overall rumination over unpleasant events, b = .12, t (393) = 3.29, p = .001, 95% CI [.05, .19] and greater frequency of brooding over unpleasant events, b = .13, t (393) = 5.00, p<.001, 95% CI [.08, .19], but overall rumination frequency did not predict negative affect, b = -.01, t (393) = -.90, p = .36, 95% CI [-.05, .02] and brooding frequency also did not predict negative affect, b = -.04, t (393) = -1.69, p = .09, 95% CI [-.09, .007]. All indirect effects of overall rumination and brooding frequency were non-significant.

[vi] The main effect of neuroticism upon affect change was not significant, b = -.006, se = .008, t (2746) = -.85, p = .38, 95% CI [-.02, -.008], but there was an interaction between event valence and neuroticism in predicting affect change, b = -.03, se = .01, t (2746) = -3.00, p = .003, 95% CI [-.05, -.01], $R^2change$ = .003, F (1, 2742) = 9.02, p = .003. Neuroticism did not predict the fading of positive affect, b = -.007, t (1385) = -1.07, p = .28, but did predict less fading of negative affect, b = -.04, t (1357) = -4.34, p<.001.

[vii] We thank an anonymous reviewer for prompting us to consider our results in this way.