Individual differences in emotional processing and autobiographical memory: Interoceptive awareness and alexithymia in the fading affect bias

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Abstract

The capacity to perceive internal bodily states is linked to emotional awareness and effective emotional regulation. We explore individual differences in emotional awareness in relation to the fading affect bias (FAB), which refers to the greater dwindling of unpleasant compared to pleasant emotions in autobiographical memory. We consider interoceptive awareness and alexithymia in relation to the FAB, and private event rehearsal as a mediating process. With increasing interoceptive awareness, there was an enhanced FAB, but with increasing alexithymia, there was a decreased FAB. Further, the effects of interoceptive awareness were partially mediated by private rehearsal of pleasant events. We provide novel evidence that capacity for emotional awareness and thus effective processing is an important factor predictive of the FAB. Moreover, our results imply an important role for maintaining positive affect in the FAB. Our findings offer new insights into the effects of interoception and alexithymia on autobiographical memory, and support concepts of the FAB emerging as a result of adaptive emotional regulation processes.

Keywords: Fading Affect Bias, autobiographical memory, emotion, alexithymia, interoceptive awareness

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Within autobiographical memory, it is adaptive to reinterpret or reconstruct our past experiences to preserve a positive view of the self (Sedikides, Skowronski, & Gaertner, 2004). A psychological phenomenon that likely illustrates such self-protective properties of the autobiographical memory system is the fading affect bias (FAB). Whilst memories of both pleasant and unpleasant events fade in emotional intensity over time, negative emotional intensity tends to fade to a greater extent compared to positive. In the current study we examine the effects of interoceptive awareness and alexithymia on the FAB and examine a potential process, private event rehearsal, through which they may exert their effects. We conclude that at the individual level, the capacity for emotional processing is an important factor influencing our experience of autobiographical memory.

Fading Affect Bias

The fading affect bias (FAB) is a now well researched phenomenon of autobiographical memory. 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 has emerged as a robust and reliable effect, appearing across cultures (Ritchie et al., 2015) and various methodological approaches adopted by researchers (Landau & Gunter, 2009). It does not appear to be as a result of differential levels of emotional arousal for pleasant versus unpleasant events (Ritchie, Skowronski, Hartnett, Wells, & Walker, 2009) or due to beliefs or strategies adopted by participants when recalling events (Ritchie et al., 2009). Events retrieved by participants in FAB studies are usually equivalent in emotional intensity when the events originally occur. Hence, the FAB seems to be as

a result of a greater drop in emotional intensity triggered by the recall of unpleasant everyday autobiographical memories compared to the recall of pleasant ones.

The FAB has been previously conceptualised as a result of effective emotional regulation mechanisms. Emotion regulation strategies operating within the autobiographical memory system act to maintain a positivity bias in event recall and produce the fading affect bias (Skowronski, 2011). In turn, this helps to promote a positive view of the self (Sedikides et al., 2004). On this basis, an individual's capacity for successful emotional processing (and thus regulation) should moderate the FAB (Walker & Skowronski, 2009). Previous research provides some evidence to support this. For example, dysphoria (mild depression) has been associated with a reduced FAB, possibly due to diminished capacity to process emotions in an adaptive way (e.g. by savoring positive emotions and/or reframing the meaning of negative events; Walker et al., 2003). Narcissism, also proposed to be associated with poor emotion regulation, is similarly related to a reduced FAB (Ritchie, Walker, Marsh, Hart, & Skowronski, 2014). In comparison, little research has examined the FAB in individuals exhibiting enhanced emotional regulation. To our knowledge only one previously unpublished study has attempted to do so. Walker, Wheeler and Brunson (2009) asked participants to complete the Zimbardo Time Perspective Inventory which classifies individuals into past-, present- or future-oriented in their attitudes towards time. They report a greater FAB (i.e. greater fading of negative affect and smaller fading of positive affect) for participants with present and future orientation compared to participants with past orientation. This implies a hopeful perspective on time could be linked to adaptive processing of autobiographical memories.

The current study extends research and theory by investigating whether an individual's capacity for emotional processing is an important factor predictive of the

FAB. To test this, we focus upon two individual differences linked with emotion processing: interoceptive awareness and alexithymia. To our knowledge this is the first published study to compare the distinct effects of personality variables that are associated with enhanced (*interoceptive awareness*) compared to diminished (*alexithymia*) emotional processing on an individual's propensity to display the FAB.

Interoceptive awareness and alexithymia in the FAB

The FAB is proposed to exist as a result of emotional regulation processes which reduce the emotional intensity of negative emotions and/or maintain the intensity of positive emotions (Walker & Skowronski, 2009). Emotion regulation processes are those which modulate emotional responses and have in particular been associated with the downregulation of negative emotional responses to unpleasant affective stimuli (Gross, 1998). Importantly, there is a role for individual difference variables in emotion regulation. Individuals with the capacity to distinguish between discrete emotional states (as opposed to treating all positive or negative valenced states as the same) have been shown to be better able to regulate their negative emotions (Feldman Barrett, Gross, Christensen, & Benvenuto, 2001). This implies that emotional regulation processes can be contingent upon an individual's ability to be aware of, pay attention to, and label emotional states.

Theories of emotion often propose a close relationship between sensitivity to bodily signals and the experience of emotions. Some early theories suggested that the perception of bodily responses was an integral part of emotional experience (Damasio, 1994). More recently, Lambie and Marcel (2002) proposed a framework that makes the distinction between the physiological arousal associated with emotions (*first-order emotional experience*) and the awareness of this arousal, often referred to as interoception (*second-order emotional experience*). Interoception can be defined

as the ability to consciously sense our own bodily states, including processes such as heartbeats and breathing (Craig, 2002), and is thought to make an important contribution to subjective emotional experience (Craig, 2004). Indeed, there is an overlap between areas of the brain involved in interoception and subjective emotional experience (Lee & Siegel, 2012). Greater performance on tasks in which participants are asked to perceive their own heartbeats (an index of sensitivity to bodily signals, i.e., interoception) is associated with greater activation in the insular cortex and anterior cingulate cortex; these are brain areas related to both monitoring internal sensations, and subjective emotional experience (Critchley, Wiens, Rotshtein, Öhman, & Dolan, 2004).

The extent of an individual's sensitivity to internal bodily signals varies (i.e., Herbert, Pollatos, Flor, Enck, & Schandry, 2010) and so has been conceptualized as an individual difference, termed *interoceptive awareness*. Recent evidence implies a role for interoceptive awareness in the successful use of emotion regulation strategies. Fustos et al. (2013) found high interoceptive awareness (as measured by high performance on a heartbeat detection task) to correlate to more successful cognitive reappraisal of unpleasant images, leading to reduced experience of negative affect. High interoceptive awareness, as measured by greater ability to detect one's own heartbeat, has also been positively associated with the self-reported tendency to use a variety of emotional regulation strategies (Kever, Pollatos, Vermeulen, & Grynberg, 2015; Pollatos, Matthias, & Keller, 2015). The capacity to perceive internal bodily signals is suggested to facilitate effective emotional regulation by providing fine-grained feedback of emotional states (Fustos et al., 2013; Pollatos et al., 2015).

In contrast, deficiencies in interoception (i.e. the second order awareness of bodily signals associated with emotions) have been proposed to explain some

symptoms of alexithymia (Silani et al., 2008). Alexithymia is characterized by difficulties in identifying, labelling, understanding and expressing emotions. Individuals who are high in alexithymia show changes in the structure and activation in the cingulate cortices and anterior insula, brain areas thought to be involved in interoceptive awareness (Berthoz et al., 2002). The anterior insula plays a role in recognizing and reflecting upon one's own emotions, and activity in this brain area is negatively correlated to a validated measure of alexithymia, the 20-item Toronto Alexithymia Scale (Silani et al., 2008). Consequently, alexithymics have difficulty in differentiating between physical sensations and emotional feelings. Deficiencies in interoception may particularly be associated with the difficulties alexithymics have in describing and expressing emotions (Silani et al., 2008). On this basis alexithymia can be conceptualized as relating negatively to interoceptive awareness, and indeed alexithymia (as measured by scores on the TAS-20) is negatively correlated to interoceptive awareness as measured using the heartbeat perception task (Herbert, Herbert, & Pollatos, 2011).

Evidence points to a role for the capacity for interoception in determining successful emotion regulation. The FAB is proposed to arise as a result of emotional regulation processes being successfully applied to the recall of emotional memories. If high interoceptive awareness is positively related to emotional regulation ability, we therefore predict increasing interoceptive awareness should be associated with enhanced FAB. In contrast, we predict alexithymia would be associated with a reduced FAB due to diminished ability to process emotions linked to autobiographical memories in an adaptive fashion.

Interoceptive awareness is frequently quantified by measuring an individual's accuracy in detecting their own heartbeats (e.g., Critchley et al., 2004). However, this

method of quantifying interoceptive awareness has been criticized in terms of the potential influence of beliefs about one's own resting heart-rate (Ring, Brener, Knapp, & Mailloux, 2015). Further, interoceptive awareness can be argued to represent a construct which is not fully encompassed by a measurement of performance in heartbeat detection. A multi-dimensional view of interoceptive awareness includes not only an awareness of body sensations, but how individuals relate to such sensations and an awareness of the connection between the body and emotions (Mehling et al., 2012). In this sense, heartbeat detection tasks provide a measure of interoceptive *sensitivity* (in terms of accuracy in perceiving bodily states) but do not tap into other aspects of interoceptive awareness, such as an individual's ability to interpret bodily states in terms of emotional states (Terasawa, Fukushima, & Umeda, 2013). We therefore chose to utilize the Multidimensional Assessment of Interoceptive Awareness (MAIA) Scale to measure interoceptive awareness (Mehling et al., 2012). This is a self-report scale designed to measure several aspects of interoceptive awareness, including ability to detect bodily signals, modes of attention towards the body, and an awareness of the connection between body signals and emotional experience. The MAIA scale has been used to identify higher interoceptive awareness in experts compared to novices in mind-body awareness therapies such as yoga (Mehling et al., 2013) and document increases in interoceptive awareness in line with a period of meditation training designed to enhance body awareness (Bornemann, Herbert, Mehling, & Singer, 2015). We expect that higher scores on the MAIA scale should be associated with an enhanced FAB.

We measured alexithymia using the 20-item Toronto Alexithymia Scale (TAS-20; Bagby, Parker, & Taylor, 1994), which is the most widely used and well validated self-report scale in assessing alexithymia. The TAS-20 measures three

factors thought to reflect the main facets of alexithymia. The difficulty describing feelings (DDF) scale measures an individual's capacity to describe emotions and emotional states; the difficulty identifying feelings (DIF) scale measures ability to identify and label emotions; and the externally oriented thinking (EOT) scale measures the extent to which an individual ignores feelings in favour of focusing attention externally. High scores on the TAS-20 have been associated with a variety of deficits in emotional recognition and awareness, such as the recall of emotional words (Luminet, Vermeulen, Demaret, Taylor, & Bagby, 2006) and the use of maladaptive emotional regulation strategies (Taylor, 2000). As such we expect that high scores on the TAS-20 should be associated with a reduced FAB. Given that previous research has identified a negative relationship between alexithymia and measures of interoceptive awareness (such as the heartbeat detection task), we also expect that scores on the TAS-20 will negatively correlate with scores on our chosen interoceptive awareness measure, the MAIA.

The mediating role of rehearsal

Little is currently known concerning the mechanisms by which various individual difference variables may exert their influence upon the FAB. Event rehearsal is an event-level variable previously implicated in moderating the FAB. The more frequently individuals privately rehearse events, the less affect intensity fades over time (Ritchie et al., 2006). Moreover, individuals report rehearsing their event memories for a variety of different reasons, including to maintain event memory, reflect on the event, or in response to environmental cues (Walker, Skowronski, Gibbons, Vogl, & Ritchie, 2009) and these different forms of private rehearsal have been associated with different patterns of affective fading (Ritchie et al., 2006). Social forms of rehearsal such as social disclosure (publicly discussing

events with others) have also been shown consistently to enhance the FAB, across both retrospective estimates of social disclosure frequency (Ritchie et al., 2006) and experimental manipulations of disclosure (Muir, Brown, & Madill, 2015; Skowronski, Gibbons, Vogl, & Walker, 2004). Previous research has found mediating effects of rehearsal frequency upon the relationship between individual difference variables and the FAB, such as drinking behaviours (Gibbons et al., 2013) and religiosity (Gibbons, Hartzler, Hartzler, Lee, & Walker, 2015). Therefore, it is reasonable to examine if the relationships of interoceptive awareness and/or alexithymia to the FAB are mediated through the frequency with which individuals rehearse pleasant or unpleasant events, and more specifically the nature of this event rehearsal (e.g. private or social rehearsal, or the type of private rehearsal). Thus, our data will additionally provide important information concerning event rehearsal as a potential process by which distinct individual difference variables may exert an influence upon the FAB.

The present research

Participants recalled three pleasant and three unpleasant event memories and rated each for emotional intensity upon event occurrence and recall, as in the standard retrospective recall FAB paradigm (i.e., Ritchie et al., 2009; Ritchie et al., 2006). For each event, participants completed a series of ratings examining the extent to which they privately rehearsed the event. We also asked participants to report frequency of social disclosure for each event, and to complete personality questionnaires assessing interoceptive awareness and alexithymia. We anticipated that these individual differences may influence the FAB in one of two ways.

The first possibility is a straightforward moderation of the FAB by one or both of the individual differences (*Hypothesis 1*). High compared to low interoceptive awareness should be associated with a larger FAB (i.e., greater fading of negative

affect and less fading of positive), and high compared to low alexithymia associated with a smaller FAB (i.e., less fading of negative affect and greater fading of positive), due to a proficiency/deficit in emotional processing respectively. Another possibility is that the effects of interoceptive awareness and/or alexithymia on the FAB are mediated through overall private rehearsal or social disclosure frequency, or the frequency of one or more specific private rehearsal types (*Hypothesis 2*). These individual differences may moderate the frequency at which individuals privately rehearse or socially disclose events which, in turn, moderate the FAB.

Method We report how we determined our sample size, all data exclusions (if any), all manipulations, and all measures in the study.

Participants

One hundred and eighty-five participants (15 males, 170 females) took part in the study, yielding statistical power of .83 to detect interactions between the FAB and individual differences of the magnitude found in previous research (ΔR^2 = .01; Ritchie et al., 2014). Participant age ranged from 18 - 36 years (*M* = 18.9 yrs., *S.D.* = 1.5). All participants were undergraduate university students who received course credit for completion of the study. Ethical approval was granted for the study from the University of Leeds Research Ethics Committee.

Individual Difference Measures

Alexithymia was assessed using the widely used Toronto Alexithymia Scale (TAS-20: 20 items, α = .84, *M* = 48.91, *S.D.* = 10.70), chosen for its good test-retest reliability and internal validity (e.g., Bagby et al., 1994). TAS-20 consists of three factors thought to capture the three facets of alexithymia: difficulty identifying feelings and distinguishing from bodily sensations (*DIF*: 7 items, α = .83, *M* = 17.08, *S.D.* = 5.39); difficulty describing feelings to others (*DDF*: 5 items, α = .83, *M* =

12.98, *S.D.* = 4.48); and externally oriented thinking (*EOT*: 8 items, α = .49, *M* = 18.63, *S.D* = 3.61). Participants respond to statements on a five point Likert scale, from 1 (*strongly disagree*) to 5 (*strongly agree*). Higher scores represent higher levels of the characteristic.

Participants also completed the self-report Multidimensional Assessment of Interoceptive Awareness scale (MAIA; Mehling et al., 2012: 32 items, α = .85, *M* = 81.72, *S.D.* = 18.41). Participants respond to statements assessing how much each statement applies to their daily life from 0 (*never*) to 5 (*always*). The MAIA assesses eight dimensions of interoceptive awareness: awareness of body sensations (*noticing*: 4 items, α = .46, *M* = 3.60, *S.D* = .61); not distracting oneself from sensations of discomfort (*not-distracting*: 3 items, α = .45, *M* = 3.01, *S.D.* = .52); not worrying about sensations of discomfort (*not-worrying*: 3 items, α = .49, *M* = 3.11, *S.D.* = .62); ability to control attention to body sensations (*attention regulation*: 7 items, α = .79, *M* = 3.53, *S.D.* = .63); awareness of the connection between body sensations and emotional states (*emotional awareness*: 5 items, α = .69, *M* = 4.01, *S.D.* = .71); ability to regulate distress by attention to body sensations (*self-regulation*: 4 items, α = .62, *M* = 3.62, *S.D.* = .51); listening to the body for insight (*body listening*: 3 items, α = .67, *M* = 3.62, *S.D.* = .61); and trusting one's body as safe (*trusting*: 3 items, α = .73, *M* = 4.13, *S.D.* = .64). Scores on each sub-scale range from 0 – 5, with total scores on the MAIA scale ranging from 0 to 160 points. High scores on each sub-scale illustrate high levels of that particular dimension, with high overall scores indicating high levels of interoceptive awareness. The MAIA shows good construct validity (Mehling et al., 2012).

Event memory retrieval and rating

Participants were instructed to recall three pleasant and three unpleasant events that they had experienced within the last 12 months, but not within the last seven days (c.f. 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. Participants then completed the following measures for each event. (1) A rating of emotional intensity upon event occurrence and recall. 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*). (2) An estimate of event age (i.e., how long ago the event occurred) in months and days. Previous research has shown the FAB cannot be explained on the basis of participants recalling significantly older unpleasant compared to pleasant events, which could lead to a misleading appearance of greater negative compared to positive affective fading (i.e., Ritchie et al., 2009). However, we explicitly control for this variable to ensure effects of specific individual difference variables on the FAB are over and above any inherent differences that may be tied to the age of events recalled within our sample. (3) A rating of how frequently each event had been privately rehearsed overall, from 1 (*very infrequently*) to 7 (*very frequently*). A private rehearsal was defined as "*any time you have privately thought about the event without discussing it with anyone else*". Participants also rated how frequently they had socially disclosed each event on the same 1 to 7 scale, with a social disclosure defined as *"any time you described or discussed the event with other people".* (4) Finally, participants were asked to estimate how frequently they had privately rehearsed each event for the following 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 (*very infrequently*) to 7 (*very frequently*).

The order of event memory retrieval was counterbalanced, with half the participants (N = 90) recalling all three pleasant event memories before all three unpleasant, and vice versa (N = 95). All measures were completed using an online questionnaire for which there was no time limit for completion.

Results

Descriptive Data: Individual Differences

The mean score on the TAS-20 for the current sample was below the proposed threshold for alexithymia (above 61: Taylor, Bagby, & Parker, 1997) and is consistent with estimated undergraduate population means on the TAS-20 (Parker, Eastabrook, Keefer, & Wood, 2010). Only 13% of participants were classed as alexithymic (28 participants: 18 females, 10 males) with scores on the TAS-20 of 61 or over, consistent with observed rates of alexithymia in undergraduate populations which range from 10% to 17% (e.g., Mason, Tyson, Jones, & Potts, 2005). The total and subscale scores on the MAIA in the current sample are comparable to normative population scores (Mehling et al., 2012). Consistent with the conceptual relationship between interoceptive awareness and alexithymia, MAIA and TAS-20 total scores were negatively related (r = -.17, p<.001).

Descriptive Data: Patterns of Fading Affect

Some participants declined to provide all six requested events, meaning 1073 events were retrieved by participants. The use of a bi-polar scale allowed the classification of events into types of affect fading. Fading affect (where intensity of

affect fades from occurrence to recall) was the most common, accounting for 560 events (52%). Fixed affect (where there is no change in affect intensity from occurrence to recall) was the next common with 418 events (41%). Flourishing affect (where affect intensity increases from occurrence to recall) accounted for 84 events (6.5%) and the least common pattern was flip affect (where the valence of event changes from occurrence to recall, e.g., from unpleasant to pleasant), which accounted for only 11 events (1.1%). This pattern of affective change is comparable to those obtained in previous FAB studies (Ritchie et al., 2009). The primary type of affect change in the present study concerned fading affect, and given flip affect events accounted for only a small percentage of the dataset, flip affect events were removed from the analysis, leaving 1062 events.

Statistical analysis

A measure of *fading affect* was computed for each event. We first computed 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. Next, we subtracted emotional intensity at recall from emotional intensity at occurrence. As in other FAB studies, positive values indicate the intensity of emotion decreased from event occurrence to recall (i.e., fading affect), whereas negative values indicate 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.

We analysed effects on fading affect at the level of the event (event valence: pleasant vs. unpleasant, private rehearsal and social disclosure frequency) and at the level of the individual (interoceptive awareness and alexithymia). Our dataset is clustered in nature; as participants recalled multiple events each (three pleasant and

three unpleasant), events are nested within individuals. Thus, in all the following analyses, a nominal level person variable was also included to control for possible between-subjects effects. The event age variable, which participants reported in months and days, was translated into the number of days since the event occurred. Some participants declined to provide an age for each recalled event, meaning 964 events had an associated age. Pleasant events (N = 475) were on average 141.84 days old ($S.D.$ = 131.60) and unpleasant events (N = 489) were 144.64 days old ($S.D$ = 116.19) which is not a significant difference (t (963) = -.35, p = .72). The event age variable was entered as a covariate in all analyses so the detection of the FAB and any significant effects of our individual difference variables cannot be attributed to the age of the event.

To test our moderation and mediation hypotheses we used the PROCESS macro for SPSS. Use of the PROCESS macro enables statistical testing of single and multiple mediator and moderator models, including estimation of two and three way interactions, simple slopes, and regions of significance for probing interactions (Hayes, 2013). The PROCESS macro is widely used and has been successfully utilized for analysis of datasets of a similar nature in previous FAB research (i.e., Gibbons et al., 2013; Ritchie et al., 2014). Firstly, we tested if the relationship between event valence (pleasant vs. unpleasant) and fading affect (i.e., the FAB) was straightforwardly moderated by interoceptive awareness or alexithymia (Model #1 within PROCESS; Hypothesis 1). Secondly, for our mediation analysis (Hypothesis 2) we used Model #8 within PROCESS. This allowed us to test for mediation of the effects of the individual difference on the FAB through frequency of overall private rehearsal, social disclosure, or the specific private rehearsal types whilst simultaneously controlling for the direct effect of the individual difference on the

FAB. This allowed us to test for full or partial mediation (Rucker, Preacher, Tormala, & Petty, 2011). For each individual difference we separately entered frequency of overall private rehearsal, social disclosure, and each of the six specific private rehearsal types as a mediator. For clarity, we report only statistically significant results in the main text (however, for transparency we report non-significant differences in footnotes).

Predicting Fading Affect from Individual Differences

Interoceptive awareness

Interoceptive awareness moderated the relationship between event valence and fading affect (b = .01, 95% CI .02, .001, t = 2.52, p = .01; ΔR^2 = .01, ΔF (1, 967) =6.31, p = .01). Figure 1a shows that the size of the FAB (i.e., greater fading of negative affect compared to positive) increased with increasing interoceptive awareness (as indicated by total MAIA scores). We also utilized the Johnson-Neyman technique within the PROCESS macro which allows detection of where the FAB did and did not occur across the full continuum of MAIA scores (Preacher, Curran, & Bauer, 2006). Results indicated that at MAIA scores from zero up to 34, there was no FAB: i.e., there was no significant difference in the extent of affective fading between pleasant and unpleasant events (b's from .18, t = .71, p = .45 through b = .16, t = 1.95, p = .06). Above MAIA scores of 35, the FAB existed (unpleasant affect faded more than pleasant) and the size of the FAB increased with increasing MAIA scores (b's from .32, t = 2.01, p = .04 through b = .82, t = 4.12, p<.001). The analyses were repeated using the eight subscales of the MAIA instead of total scores. However, no significant effects were detected, indicating no one dimension of the MAIA scale was responsible for the reported effects[1].

<Figure 1 about here>

We next explored if increased negative or decreased positive affective fading were equally responsible for the enhanced FAB in association with increasing interoceptive awareness. We predicted fading affect scores for pleasant events from MAIA total scores, and separately predicted fading affect scores for unpleasant events from MAIA scores. We utilized a linear mixed model in which we accounted for the clustering in the data resulting from memories nested within individuals (Heck, Thomas, & Tabata, 2014, pp. 4 - 11). With increasing interoceptive awareness, positive affect faded less (b = -.002, t (469) = -1.66, p = .05), but interoceptive awareness did not predict fading affect scores for unpleasant events (b = .001, t (475) = .38, p = .69).

Finally, we examined if the effects of interoceptive awareness upon the FAB were mediated through frequency of overall private rehearsal, social disclosure, or one or more of the specific private rehearsal types. The only significant results were in respect of the frequency of private rehearsals in response to one's own moods[2]. Firstly, there was an interaction between event valence and interoceptive awareness (MAIA total scores) in predicting frequency of mood rehearsals (b = -.01, t = -1.99, p = .04, 95% CI -.03, -.0002). Pleasant events were coded as 0 and unpleasant as 1, so the coefficient is interpreted as increasing interoceptive awareness predicts greater frequency of private rehearsal of pleasant event memories in response to mood compared to unpleasant. Mood rehearsals also predicted fading affect scores: with greater frequency of private rehearsals in response to mood, the less affect faded (b = -.11, t = -7.46, p<.001, 95% CI -.85, -.09).

Together, this suggests that increasing interoceptive awareness was associated with greater private rehearsal of pleasant events in response to mood in comparison to unpleasant, which was in turn associated with less fading of affect. Using bias

corrected bootstrapping with 1,000 resamples the indirect effect was estimated as *b* = .001, 95% CI .003, .0001. As the 95% CI do not pass through zero, the mediating effect of private rehearsals in response to mood on the effects of interoceptive awareness on the FAB is statistically significant (Hayes, 2015). The direct effect of interoceptive awareness on the FAB was still significant (*b* = .009, 95% CI .01, .001) suggesting partial mediation by private rehearsals in response to mood[3].

Alexithymia

Alexithymia moderated the relationship between event valence and fading affect (*b* = -.02, 95% CI -.01, -.03, *t* = -2.52, *p* = .01; ΔR^2 = .01, ΔF (1, 967) =6.42, *p* = .01). Figure 1b illustrates this moderation effect. The size of the FAB decreased with increasing alexithymia, in that pleasant affect faded more and unpleasant affect faded less. We again used the Johnson-Neyman technique within PROCESS, which indicated at TAS-20 scores of up to 60, the FAB existed (i.e., there was greater fading of unpleasant compared to pleasant affect intensity) but it decreased in size with increasing alexithymia (*b*s from .90, *t* = 6.61, *p*<.001, through *b* = .23, *t* = 1.91, *p* = .05). When TAS-20 scores reached higher than 61 (above the diagnostic criteria for alexithymia) there was no FAB: unpleasant and pleasant affect faded to the same extent (*b* = .18, *t* = 1.43, *p* = .17). The analyses were repeated using the three subscales of TAS-20 instead of total scores (i.e., the DIF, DDF and EOT scores). However, no significant effects were detected with use of the three sub-scales, indicating no one sub scale of the TAS-20 was responsible for the reported effects[4].

We next explored if decreased negative or increased positive affective fading were equally responsible for the decreased FAB in association with alexithymia. With increasing alexithymia, the more positive affect faded (*b* = .008, *t* (480) = 2.09, *p* = .03) but alexithymia did not predict fading affect scores for unpleasant events (*b*

= .006, t (475) = 1.30, p = .19). Finally, our mediation analyses indicated no significant mediators of the effects of alexithymia upon the FAB[5].

Discussion

We found significant moderating effects of interoceptive awareness on the FAB. With increasing interoceptive awareness, the size of the FAB increased (pleasant affect faded less and unpleasant affect faded more). This suggests that awareness of emotional states is involved in the development of the FAB. Our results regarding alexithymia are consistent with this view. We found a negative relationship between our measures of alexithymia and interoceptive awareness. Further, with increasing alexithymia, the size of the FAB decreased (pleasant affect faded more and unpleasant affect faded less). Where there are deficits in emotional awareness, recognition and labelling, the FAB is reduced or even absent.

Emotional awareness and the FAB

Our results are consistent with the idea that emotional regulation is shaped by individual differences in the ability to perceive internal bodily signals (e.g., Fustos et al., 2013). A high level of ability in perceiving bodily signals is suggested to enable effective emotional regulation through the capacity to discriminate between emotional states as they occur (Fustos et al., 2013; Pollatos et al., 2015). Presumably, this then confers an advantage in regulating these emotional states (e.g., Feldman Barrett et al., 2001). We also found that interoceptive awareness was more predictive of less fading of pleasant affect than greater fading of unpleasant. This suggests that potentially, a prime mechanism by which interoceptive awareness influences the fate of emotions in autobiographical memory is through preserving positive affect. This would be in line with evidence suggesting a connection between low interoceptive

awareness and lower experienced intensity of positive emotions (Furman, Waugh, Bhattacharjee, Thompson, & Gotlib, 2013).

Further, high interoceptive awareness is proposed to facilitate the effectiveness of a variety of emotional regulation strategies (Fustos et al., 2013). Our results suggest that one such strategy employed by individuals with high interoceptive awareness could plausibly be frequent private rehearsal of pleasant event memories. We found that interoceptive awareness predicted greater tendency to rehearse pleasant events in response to mood, which in turn predicted less fading of affect. The connection between interoceptive awareness and mood rehearsals makes sense in the context of interoceptive awareness's positive relationship to subjective emotional experience. High levels of interoceptive awareness (and with it, the capacity to identify and access positive moods easily) could mean positive moods are experienced more frequently. Greater frequency of positive moods could then be associated with greater frequency of positive event private rehearsal in response, and thus the retention of positive affect. Indeed, our findings showed frequency of private rehearsals in response to mood partially mediated the effects of interoceptive awareness. This signifies that frequency of private rehearsals contributes to the effects of interoceptive awareness on the FAB.

In contrast to interoceptive awareness, alexithymia negatively predicted the FAB. Alexithymia is thought to represent a deficit in *meta-emotional processing*: the impaired capacity to construct mental representations of emotions and cognitively process emotional experiences (Lundh, Johnsson, Sundqvist, & Olsson, 2002). Our results are consistent with this idea, and with evidence of diminished cognitive processing of emotions in alexithymics (Luminet, Rimé, Bagby, & Taylor, 2004). Further, it has been suggested that low levels of interoceptive awareness are a

predictor of alexithymia (Herbert et al., 2011); since capacity for perceiving internal bodily signals is involved in emotional awareness, when this is compromised, this forms a basis for alexithymia. Our results are in line with this view as our measures of interoceptive awareness and alexithymia were negatively related, and interoceptive awareness and alexithymia showed contrasting relationships to the FAB.

Our finding that alexithymia was predictive of greater fading of positive affect is also consistent with studies demonstrating a link between alexithymia and reduced experience of positive affect. For instance, higher scores on the TAS-20 are associated with lower reported intensity of positive emotional experience (Fantini-Hauwel, Luminet, & Vermeulen, 2015). Moreover, research has reported reduced activation in the posterior cingulate cortex when individuals with high alexithymia (as indicated by scores on TAS-20) were asked to remember past happy events. Activation in this area is associated with episodic memory retrieval, and is reciprocally connected to the anterior cingulate cortex, which is linked to emotion processing (Mantani, Okamoto, Shirao, Okada, & Yamawaki, 2005). Together, this suggests that the deficits in emotional processing in alexithymia are particularly acute for positive stimuli, leading to greater fading of positive affect in autobiographical memory.

Implications for theories of the FAB

The FAB is thought to exist as a result of self-enhancement and self-protection motives, which maintain positivity in autobiographical memory by re-interpreting or reconstructing events in a self-serving way (Skowronski, 2011; Walker & Skowronski, 2009). Self-enhancement motivations increase or maintain positivity of event memories to preserve the positive view of the self, and self-protection motives act as damage limitation, marshalling defenses against negative feedback or events.

The FAB, then, is thought to exist as the result of cognitive, emotional, and social processes driven by self-enhancement and self-protective motivations which act to maintain positive, and minimize negative emotional intensity experienced by individuals upon the retrieval of autobiographical memories (Skowronski, 2011). Our results, which indicate that the FAB is disrupted in individuals with diminished emotional processing abilities, are therefore highly consistent with the emotional regulation theory of the FAB.

Further, our results imply that maintaining positive affect is just as important, if not more so, as diminishing negative affect for the development of the FAB. Interoceptive awareness and alexithymia were related to the FAB via an influence on positive affective fading, more so than negative fading. Moreover, the mediating effect of private rehearsal upon interoceptive awareness's effects on the FAB were specific to pleasant event private rehearsals. These results suggest that the capacity to access, identify and maintain positive emotions can be conceptualized as a central part of emotional regulation processes operating on autobiographical memory. Thus, we propose that self-enhancement motives, in terms of maintaining positive affect in relation to the self, make an important contribution to the development of the FAB.

Limitations and future directions

We found that only total MAIA scores moderated the FAB, indicating that a combination of the various dimensions involved in interoceptive awareness (as measured by the MAIA), and not any one in particular, were responsible for the effects we observed. This makes sense in light of a multidimensional conceptualization of interoceptive awareness: where individuals have high levels of interoceptive awareness, they are able implicitly to use information from their body to evaluate their own emotional state, regulate distress by paying attention to bodily

sensations, and to effectively utilize emotional regulation strategies. However, we also found that several subscales of the MAIA had low internal reliability. Other studies using the MAIA scale have also reported low reliability of some of the sub-scales (Bornemann et al., 2015). This suggests the MAIA scale would benefit from further definition and validation work, and perhaps addition of further items to increase reliability of the scales with low item numbers.

We also found low reliability of the externally oriented thinking (EOT) sub-scale of the TAS-20. Similarly, other researchers have reported low internal reliability of this sub-scale (Loas et al., 2001). Indeed, some alexithymia researchers have suggested the EOT scale taps into a completely separate aspect of alexithymia, and the TAS-20 would be more reliable with a reworked two factor structure, including items from the DIF and DDF sub-scales (Kooiman, Spinhoven, & Trijsburg, 2002).

We selected these two self-report measures (MAIA and TAS-20) as they are widely used, along with being quick and simple to administer. However, there are acknowledged issues with the use of self-report measures for personality traits. Effective use of self-report measures relies on individuals having insight into their own personality (which in turn, relies on the retrieval of self-knowledge from semantic memory), and reporting personality traits without being influenced by self-presentation bias or demand characteristics. It would therefore be worthwhile to examine the FAB in relation to other behavioural measures of emotional processing ability. One alternative measure of emotional processing ability is the LEAS (Lane, Quinlan, Schwartz, Walker, & Zeitlin, 1990) which involves a direct assessment of emotional processing and recognition not dependent on self-report. Along similar lines, the heartbeat detection test assesses interoceptive ability behaviorally

(Schandry, 1981). Although not as simple to administer, these two measures would be useful additions to future FAB research to supplement and validate self-report methods of emotional processing ability.

A similar contention can be made against the use of retrospective recall of autobiographical memories in that people could be inaccurate in their recall of emotional intensity related to specific autobiographical events. However, both daily diary and retrospective recall paradigms are used in FAB research and both methods tend to result in the FAB. Indeed, one study which directly compared the two methods concluded that the only limitation in retrospective recall paradigms is a slight reduction in statistical power to detect the FAB in comparison to daily diary methods (Ritchie et al., 2009).

Conclusion

The current study shows that individual differences that influence emotional processing ability moderate the size of the FAB. By examining the roles of interoceptive awareness and alexithymia in the FAB, we have provided novel evidence that the capacity for emotional awareness and thus effective emotional processing is an important factor predictive of the FAB. We therefore add important evidence to a steadily growing research base supporting the theory that the FAB emerges due to emotion regulation processes operating in autobiographical memory, as a result of psychological motivations to protect the positivity of the self.

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[1] None of the subscales of the MAIA measure moderated the relationship between event valence and fading affect using Model #1 (Notice: b = -.01, t = -.36, p = .71, 95% CI -.08, .06; Not-distract: b = -.04, t = -1.42, p = .15, 95% CI -.11, .02; Not-worry: b = .01, t = .39, p = .73, 95% CI -.06, .08; Trust: b = .02, t = .09, p = .92, 95% CI -.47, .52; Attention Regulation: b = .02, t = .73, p = .46, 95% CI -.04, .08; Self-regulation: b = -.04, t = -1.69, p = .09, 95% CI -.10, .01; body listening: b = -.03, t = -1.27, p = .20, 95% CI -.14, .10; emotional awareness: b = -.02, t = -.33, p = .73, 95% CI -.14, .10).

[2] The effects of MAIA total scores on the FAB were not mediated through social disclosure frequency (b = .0004, 95% CI -.0002, .001) or overall private rehearsal frequency (b = -.0009, 95% CI -.003, .0007). Apart from private rehearsals in response to mood, none of the other specific private rehearsal types emerged as significant mediators (no reason: b = -.002, 95% CI -.003, .005; cues: b = -.0006, 95% CI -.002, .0005; reflect: b = .0004, 95% CI -.0003, .001; remember: b = -.0005, 95% CI -.001, .0004; feel: b = .0008, 95% CI -.0002, .002).

[3] To confirm the robustness of our findings we re-ran the PROCESS macro increasing the resample size to 5000 whilst keeping an alpha of .05. Similar values of the estimates were obtained when using these parameters.

[4] None of the subscales of the TAS-20 were significant moderators of the FAB using Model #1 (DIF: b = .01, t = 1.32, p = .18, 95% CI -.01, .04; DDF: b = .03, t = 1.60, p = .11, 95% CI -.01, .07; EOT: b = -.001, t = -.05, p = .96, 95% CI -.04, .04).

[5] The effects of TAS-20 total scores upon the FAB were not mediated through social disclosure frequency (b = -.0007, 95% CI -.0024, .0004) or overall private rehearsal frequency (b = .004, 95% CI -.001, .007). None of the specific private rehearsal types emerged as significant mediators (no reason: b = .002, 95% CI -.001, .006; cues: b = .001, 95% CI -.009, .003; mood: (b = .003, 95% CI -.0001, .006); reflect: b = .001, 95% CI -.002, .001; remember: b = .001, 95% CI -.003, .004; feel: b = -.002, 95% CI -.003, .002).

Figure 1. *Fading Affect Scores as a function of event valence (pleasant vs. unpleasant), interoceptive awareness and alexithymia. Actual MAIA and TAS-20 scores are given in brackets*.