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5 **Individual differences in emotional processing and autobiographical memory:**

6 **Interoceptive awareness and alexithymia in the fading affect bias**

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Abstract

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

39

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

42 Individual differences in emotional processing and autobiographical memory:**43 Interoceptive awareness and alexithymia in the fading affect bias**

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

55 *Fading Affect Bias*

56 The fading affect bias (FAB) is a now well researched phenomenon of
57 autobiographical memory. The FAB describes the greater fading of negative
58 compared to positive affect associated with memories of personally experienced,
59 everyday events (Walker & Skowronski, 2009). The FAB has emerged as a robust
60 and reliable effect, appearing across cultures (Ritchie et al., 2015) and various
61 methodological approaches adopted by researchers (Landau & Gunter, 2009). It does
62 not appear to be as a result of differential levels of emotional arousal for pleasant
63 versus unpleasant events (Ritchie, Skowronski, Hartnett, Wells, & Walker, 2009) or
64 due to beliefs or strategies adopted by participants when recalling events (Ritchie et
65 al., 2009). Events retrieved by participants in FAB studies are usually equivalent in
66 emotional intensity when the events originally occur. Hence, the FAB seems to be as

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

69 The FAB has been previously conceptualised as a result of effective
70 emotional regulation mechanisms. Emotion regulation strategies operating within the
71 autobiographical memory system act to maintain a positivity bias in event recall and
72 produce the fading affect bias (Skowronski, 2011). In turn, this helps to promote a
73 positive view of the self (Sedikides et al., 2004). On this basis, an individual's
74 capacity for successful emotional processing (and thus regulation) should moderate
75 the FAB (Walker & Skowronski, 2009). Previous research provides some evidence to
76 support this. For example, dysphoria (mild depression) has been associated with a
77 reduced FAB, possibly due to diminished capacity to process emotions in an adaptive
78 way (e.g. by savoring positive emotions and/or reframing the meaning of negative
79 events; Walker et al., 2003). Narcissism, also proposed to be associated with poor
80 emotion regulation, is similarly related to a reduced FAB (Ritchie, Walker, Marsh,
81 Hart, & Skowronski, 2014). In comparison, little research has examined the FAB in
82 individuals exhibiting enhanced emotional regulation. To our knowledge only one
83 previously unpublished study has attempted to do so. Walker, Wheeler and Brunson
84 (2009) asked participants to complete the Zimbardo Time Perspective Inventory
85 which classifies individuals into past-, present- or future-oriented in their attitudes
86 towards time. They report a greater FAB (i.e. greater fading of negative affect and
87 smaller fading of positive affect) for participants with present and future orientation
88 compared to participants with past orientation. This implies a hopeful perspective on
89 time could be linked to adaptive processing of autobiographical memories.

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

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

97 ***Interoceptive awareness and alexithymia in the FAB***

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

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

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

127 The extent of an individual's sensitivity to internal bodily signals varies (i.e.,
128 Herbert, Pollatos, Flor, Enck, & Schandry, 2010) and so has been conceptualized as
129 an individual difference, termed *interoceptive awareness*. Recent evidence implies a
130 role for interoceptive awareness in the successful use of emotion regulation strategies.
131 Fustos et al. (2013) found high interoceptive awareness (as measured by high
132 performance on a heartbeat detection task) to correlate to more successful cognitive
133 reappraisal of unpleasant images, leading to reduced experience of negative affect.
134 High interoceptive awareness, as measured by greater ability to detect one's own
135 heartbeat, has also been positively associated with the self-reported tendency to use a
136 variety of emotional regulation strategies (Kever, Pollatos, Vermeulen, & Grynberg,
137 2015; Pollatos, Matthias, & Keller, 2015). The capacity to perceive internal bodily
138 signals is suggested to facilitate effective emotional regulation by providing fine-
139 grained feedback of emotional states (Fustos et al., 2013; Pollatos et al., 2015).

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

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

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

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

167 method of quantifying interoceptive awareness has been criticized in terms of the
168 potential influence of beliefs about one's own resting heart-rate (Ring, Brener, Knapp,
169 & Mailloux, 2015). Further, interoceptive awareness can be argued to represent a
170 construct which is not fully encompassed by a measurement of performance in
171 heartbeat detection. A multi-dimensional view of interoceptive awareness includes
172 not only an awareness of body sensations, but how individuals relate to such
173 sensations and an awareness of the connection between the body and emotions
174 (Mehling et al., 2012). In this sense, heartbeat detection tasks provide a measure of
175 interoceptive *sensitivity* (in terms of accuracy in perceiving bodily states) but do not
176 tap into other aspects of interoceptive awareness, such as an individual's ability to
177 interpret bodily states in terms of emotional states (Terasawa, Fukushima, & Umeda,
178 2013). We therefore chose to utilize the Multidimensional Assessment of
179 Interoceptive Awareness (MAIA) Scale to measure interoceptive awareness (Mehling
180 et al., 2012). This is a self-report scale designed to measure several aspects of
181 interoceptive awareness, including ability to detect bodily signals, modes of attention
182 towards the body, and an awareness of the connection between body signals and
183 emotional experience. The MAIA scale has been used to identify higher interoceptive
184 awareness in experts compared to novices in mind-body awareness therapies such as
185 yoga (Mehling et al., 2013) and document increases in interoceptive awareness in line
186 with a period of meditation training designed to enhance body awareness
187 (Bornemann, Herbert, Mehling, & Singer, 2015). We expect that higher scores on the
188 MAIA scale should be associated with an enhanced FAB.

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

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

206 *The mediating role of rehearsal*

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

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

230 *The present research*

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

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

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

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

252 *Participants*

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

260 *Individual Difference Measures*

261 Alexithymia was assessed using the widely used Toronto Alexithymia Scale
262 (TAS-20: 20 items, $\alpha = .84$, $M = 48.91$, $S.D. = 10.70$), chosen for its good test-retest
263 reliability and internal validity (e.g., Bagby et al., 1994). TAS-20 consists of three
264 factors thought to capture the three facets of alexithymia: difficulty identifying
265 feelings and distinguishing from bodily sensations (*DIF*: 7 items, $\alpha = .83$, $M = 17.08$,
266 $S.D. = 5.39$); difficulty describing feelings to others (*DDF*: 5 items, $\alpha = .83$, $M =$

267 12.98, $S.D.$ = 4.48); and externally oriented thinking (*EOT*: 8 items, α = .49, M =
268 18.63, $S.D.$ = 3.61). Participants respond to statements on a five point Likert scale,
269 from 1 (*strongly disagree*) to 5 (*strongly agree*). Higher scores represent higher
270 levels of the characteristic.

271 Participants also completed the self-report Multidimensional Assessment of
272 Interoceptive Awareness scale (MAIA; Mehling et al., 2012: 32 items, α = .85, M =
273 81.72, $S.D.$ = 18.41). Participants respond to statements assessing how much each
274 statement applies to their daily life from 0 (*never*) to 5 (*always*). The MAIA assesses
275 eight dimensions of interoceptive awareness: awareness of body sensations (*noticing*:
276 4 items, α = .46, M = 3.60, $S.D.$ = .61); not distracting oneself from sensations of
277 discomfort (*not-distracting*: 3 items, α = .45, M = 3.01, $S.D.$ = .52); not worrying
278 about sensations of discomfort (*not-worrying*: 3 items, α = .49, M = 3.11, $S.D.$ = .62);
279 ability to control attention to body sensations (*attention regulation*: 7 items, α = .79,
280 M = 3.53, $S.D.$ = .63); awareness of the connection between body sensations and
281 emotional states (*emotional awareness*: 5 items, α = .69, M = 4.01, $S.D.$ = .71); ability
282 to regulate distress by attention to body sensations (*self-regulation*: 4 items, α = .62,
283 M = 3.62, $S.D.$ = .51); listening to the body for insight (*body listening*: 3 items, α
284 = .67, M = 3.62, $S.D.$ = .61); and trusting one's body as safe (*trusting*: 3 items, α
285 = .73, M = 4.13, $S.D.$ = .64). Scores on each sub-scale range from 0 – 5, with total
286 scores on the MAIA scale ranging from 0 to 160 points. High scores on each sub-
287 scale illustrate high levels of that particular dimension, with high overall scores
288 indicating high levels of interoceptive awareness. The MAIA shows good construct
289 validity (Mehling et al., 2012).

290 ***Event memory retrieval and rating***

291 Participants were instructed to recall three pleasant and three unpleasant
292 events that they had experienced within the last 12 months, but not within the last
293 seven days (c.f. Skowronski et al., 2004). For each event, participants were asked to
294 provide a title, which acted as a memory cue later on in the study, and to write a brief
295 description of the event. Participants then completed the following measures for each
296 event. (1) A rating of emotional intensity upon event occurrence and recall.
297 Participants were asked to rate “*How intense were the emotions you felt when this*
298 *event originally happened?*” and “*How intense are the emotions you feel when*
299 *remembering this event now?*”, both on a bipolar scale from +3 (*extremely pleasant*)
300 through 0 (*neutral*) to -3 (*extremely unpleasant*). (2) An estimate of event age (i.e.,
301 how long ago the event occurred) in months and days. Previous research has shown
302 the FAB cannot be explained on the basis of participants recalling significantly older
303 unpleasant compared to pleasant events, which could lead to a misleading appearance
304 of greater negative compared to positive affective fading (i.e., Ritchie et al., 2009).
305 However, we explicitly control for this variable to ensure effects of specific individual
306 difference variables on the FAB are over and above any inherent differences that may
307 be tied to the age of events recalled within our sample. (3) A rating of how frequently
308 each event had been privately rehearsed overall, from 1 (*very infrequently*) to 7 (*very*
309 *frequently*). A private rehearsal was defined as “*any time you have privately thought*
310 *about the event without discussing it with anyone else*”. Participants also rated how
311 frequently they had socially disclosed each event on the same 1 to 7 scale, with a
312 social disclosure defined as “*any time you described or discussed the event with other*
313 *people*”. (4) Finally, participants were asked to estimate how frequently they had
314 privately rehearsed each event for the following reasons (c.f. Ritchie et al., 2006): a)
315 for no apparent reason; b) in response to one’s own mood; c) when reminded to by

316 environmental cues; d) to reflect on the meaning of the event or to better understand
317 it; e) so it is not forgotten; f) to make myself think or feel about myself in a certain
318 way. These ratings were made on a scale from 1 (*very infrequently*) to 7 (*very*
319 *frequently*).

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

324 **Results**

325 *Descriptive Data: Individual Differences*

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

337 *Descriptive Data: Patterns of Fading Affect*

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

341 affect fades from occurrence to recall) was the most common, accounting for 560
342 events (52%). Fixed affect (where there is no change in affect intensity from
343 occurrence to recall) was the next common with 418 events (41%). Flourishing affect
344 (where affect intensity increases from occurrence to recall) accounted for 84 events
345 (6.5%) and the least common pattern was flip affect (where the valence of event
346 changes from occurrence to recall, e.g., from unpleasant to pleasant), which accounted
347 for only 11 events (1.1%). This pattern of affective change is comparable to those
348 obtained in previous FAB studies (Ritchie et al., 2009). **The primary type of affect**
349 **change in the present study concerned fading affect, and given flip affect events**
350 **accounted for only a small percentage of the dataset, flip affect events were removed**
351 **from the analysis, leaving 1062 events.**

352 *Statistical analysis*

353 A measure of *fading affect* was computed for each event. We first computed
354 the absolute value of the negative ratings to ensure each event's ratings of affect
355 intensity at occurrence and recall ranged from a positive value (max of 3) to zero.
356 Next, we subtracted emotional intensity at recall from emotional intensity at
357 occurrence. As in other FAB studies, positive values indicate the intensity of emotion
358 decreased from event occurrence to recall (i.e., fading affect), whereas negative
359 values indicate emotion increased in intensity from event occurrence to recall. The
360 size of the value indicates the extent of change, with greater values indicating greater
361 change in emotional intensity between event occurrence and recall.

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

366 three unpleasant), events are nested within individuals. Thus, in all the following
367 analyses, a nominal level person variable was also included to control for possible
368 between-subjects effects. The event age variable, which participants reported in
369 months and days, was translated into the number of days since the event occurred.
370 **Some participants declined to provide an age for each recalled event, meaning 964**
371 **events had an associated age.** Pleasant events ($N = 475$) were on average 141.84 days
372 old ($S.D. = 131.60$) and unpleasant events ($N = 489$) were 144.64 days old ($S.D. =$
373 116.19) which is not a significant difference ($t(963) = -.35, p = .72$). The event age
374 variable was entered as a covariate in all analyses so the detection of the FAB and any
375 significant effects of our individual difference variables cannot be attributed to the age
376 of the event.

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

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

397 **Predicting Fading Affect from Individual Differences**

398 *Interoceptive awareness*

399 Interoceptive awareness moderated the relationship between event valence and
400 fading affect ($b = .01$, 95% CI .02, .001, $t = 2.52$, $p = .01$; $\Delta R^2 = .01$, $\Delta F(1, 967)$
401 $= 6.31$, $p = .01$). Figure 1a shows that the size of the FAB (i.e., greater fading of
402 negative affect compared to positive) increased with increasing interoceptive
403 awareness (as indicated by total MAIA scores). We also utilized the Johnson-
404 Neyman technique within the PROCESS macro which allows detection of where the
405 FAB did and did not occur across the full continuum of MAIA scores (Preacher,
406 Curran, & Bauer, 2006). Results indicated that at MAIA scores from zero up to 34,
407 there was no FAB: i.e., there was no significant difference in the extent of affective
408 fading between pleasant and unpleasant events (b 's from .18, $t = .71$, $p = .45$ through
409 $b = .16$, $t = 1.95$, $p = .06$). Above MAIA scores of 35, the FAB existed (unpleasant
410 affect faded more than pleasant) and the size of the FAB increased with increasing
411 MAIA scores (b 's from .32, $t = 2.01$, $p = .04$ through $b = .82$, $t = 4.12$, $p < .001$). The
412 analyses were repeated using the eight subscales of the MAIA instead of total scores.
413 However, no significant effects were detected, indicating no one dimension of the
414 MAIA scale was responsible for the reported effects¹.

415 <Figure 1 about here>

416 We next explored if increased negative or decreased positive affective fading
417 were equally responsible for the enhanced FAB in association with increasing
418 interoceptive awareness. We predicted fading affect scores for pleasant events from
419 MAIA total scores, and separately predicted fading affect scores for unpleasant events
420 from MAIA scores. We utilized a linear mixed model in which we accounted for the
421 clustering in the data resulting from memories nested within individuals (Heck,
422 Thomas, & Tabata, 2014, pp. 4 - 11). With increasing interoceptive awareness,
423 positive affect faded less ($b = -.002$, $t(469) = -1.66$, $p = .05$), but interoceptive
424 awareness did not predict fading affect scores for unpleasant events ($b = .001$, $t(475)$
425 $= .38$, $p = .69$).

426 Finally, we examined if the effects of interoceptive awareness upon the FAB
427 were mediated through frequency of overall private rehearsal, social disclosure, or
428 one or more of the specific private rehearsal types. The only significant results were
429 in respect of the frequency of private rehearsals in response to one's own moods².
430 Firstly, there was an interaction between event valence and interoceptive awareness
431 (MAIA total scores) in predicting frequency of mood rehearsals ($b = -.01$, $t = -1.99$, p
432 $= .04$, 95% CI $-.03$, $-.0002$). Pleasant events were coded as 0 and unpleasant as 1, so
433 the coefficient is interpreted as increasing interoceptive awareness predicts greater
434 frequency of private rehearsal of pleasant event memories in response to mood
435 compared to unpleasant. Mood rehearsals also predicted fading affect scores: with
436 greater frequency of private rehearsals in response to mood, the less affect faded ($b =$
437 $-.11$, $t = -7.46$, $p < .001$, 95% CI $-.85$, $-.09$).

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

441 corrected bootstrapping with 1,000 resamples the indirect effect was estimated as b
 442 = .001, 95% CI .003, .0001. As the 95% CI do not pass through zero, the mediating
 443 effect of private rehearsals in response to mood on the effects of interoceptive
 444 awareness on the FAB is statistically significant (Hayes, 2015). The direct effect of
 445 interoceptive awareness on the FAB was still significant ($b = .009$, 95% CI .01, .001)
 446 suggesting partial mediation by private rehearsals in response to mood³.

447 *Alexithymia*

448 Alexithymia moderated the relationship between event valence and fading
 449 affect ($b = -.02$, 95% CI -.01, -.03, $t = -2.52$, $p = .01$; $\Delta R^2 = .01$, $\Delta F(1, 967) = 6.42$, p
 450 = .01). Figure 1b illustrates this moderation effect. The size of the FAB decreased
 451 with increasing alexithymia, in that pleasant affect faded more and unpleasant affect
 452 faded less. We again used the Johnson-Neyman technique within PROCESS, which
 453 indicated at TAS-20 scores of up to 60, the FAB existed (i.e., there was greater fading
 454 of unpleasant compared to pleasant affect intensity) but it decreased in size with
 455 increasing alexithymia (bs from .90, $t = 6.61$, $p < .001$, through $b = .23$, $t = 1.91$, p
 456 = .05). When TAS-20 scores reached higher than 61 (above the diagnostic criteria for
 457 alexithymia) there was no FAB: unpleasant and pleasant affect faded to the same
 458 extent ($b = .18$, $t = 1.43$, $p = .17$). The analyses were repeated using the three
 459 subscales of TAS-20 instead of total scores (i.e., the DIF, DDF and EOT scores).
 460 However, no significant effects were detected with use of the three sub-scales,
 461 indicating no one sub scale of the TAS-20 was responsible for the reported effects⁴.

462 We next explored if decreased negative or increased positive affective fading
 463 were equally responsible for the decreased FAB in association with alexithymia.
 464 With increasing alexithymia, the more positive affect faded ($b = .008$, $t(480) = 2.09$,
 465 $p = .03$) but alexithymia did not predict fading affect scores for unpleasant events (b

466 = .006, $t(475) = 1.30$, $p = .19$). Finally, our mediation analyses indicated no
467 significant mediators of the effects of alexithymia upon the FAB⁵.

468 **Discussion**

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

479 *Emotional awareness and the FAB*

480 Our results are consistent with the idea that emotional regulation is shaped by
481 individual differences in the ability to perceive internal bodily signals (e.g., Fustos et
482 al., 2013). A high level of ability in perceiving bodily signals is suggested to enable
483 effective emotional regulation through the capacity to discriminate between emotional
484 states as they occur (Fustos et al., 2013; Pollatos et al., 2015). Presumably, this then
485 confers an advantage in regulating these emotional states (e.g., Feldman Barrett et al.,
486 2001). We also found that interoceptive awareness was more predictive of less
487 fading of pleasant affect than greater fading of unpleasant. This suggests that
488 potentially, a prime mechanism by which interoceptive awareness influences the fate
489 of emotions in autobiographical memory is through preserving positive affect. This
490 would be in line with evidence suggesting a connection between low interoceptive

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

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

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

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

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

534 *Implications for theories of the FAB*

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

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

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

558 *Limitations and future directions*

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

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

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

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

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

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

602 *Conclusion*

603 The current study shows that individual differences that influence emotional
604 processing ability moderate the size of the FAB. By examining the roles of
605 interoceptive awareness and alexithymia in the FAB, we have provided novel
606 evidence that the capacity for emotional awareness and thus effective emotional
607 processing is an important factor predictive of the FAB. We therefore add important
608 evidence to a steadily growing research base supporting the theory that the FAB
609 emerges due to emotion regulation processes operating in autobiographical memory,
610 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: $b = -.01, t = -.36, p = .71, 95\% \text{ CI } -.08, .06$; Not-distract: $b = -.04, t = -1.42, p = .15, 95\% \text{ CI } -.11, .02$; Not-worry: $b = .01, t = .39, p = .73, 95\% \text{ CI } -.06, .08$; Trust: $b = .02, t = .09, p = .92, 95\% \text{ CI } -.47, .52$; Attention Regulation: $b = .02, t = .73, p = .46, 95\% \text{ CI } -.04, .08$; Self-regulation: $b = -.04, t = -1.69, p = .09, 95\% \text{ CI } -.10, .01$; body listening: $b = -.03, t = -1.27, p = .20, 95\% \text{ CI } -.14, .10$; emotional awareness: $b = -.02, t = -.33, p = .73, 95\% \text{ CI } -.14, .10$).

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

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: $b = .01, t = 1.32, p = .18, 95\% \text{ CI } -.01, .04$; DDF: $b = .03, t = 1.60, p = .11, 95\% \text{ CI } -.01, .07$; EOT: $b = -.001, t = -.05, p = .96, 95\% \text{ CI } -.04, .04$).

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

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.*