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Abstract

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We examined age-related differences in the reactive and proactive use of affect regulation strategies. We collected data from 209 participants aged 13-80 years, using an experience sampling method. The most interesting finding was that, as hypothesized, compared with the under-20s, adults aged 20 years and over used the two strategies we focused on (i.e., problem solving and positive reappraisal) more intensely and in a reactive manner. By contrast, from the age of about 55 years upwards, adults were characterized by a more intensely proactive use of these strategies. Results are discussed in the light of age differences in motivation.

Keywords: affect regulation, affective experience, experience sampling method, eudaimonic vs hedonic

Abstract: 99 words

Text: 264 lines

Reactive or Proactive? Age Differences in the Use of Affective Regulation Strategies

Research on emotional aging has revealed a paradox whereby adults in their 60s tend to feel more positive affect (PA) and/or less negative affect (NA) than adults aged 20-30 years (Carstensen et al., 2011; Gross et al., 1997; Mroczek & Kolarz, 1998; Riediger, Voelkle, Ebner, & Lindenberger, 2011). This finding has frequently been interpreted as reflecting the fact that older adults have better affective skills and greater motivation than their younger counterparts. A recent systematic review provided support for this idea (Doerwald, Scheibe, Zacher, & Van Yperen, 2016), by showing that older adults regulate their affect in a slightly more efficient manner than younger adults. These age differences in affect regulation may, in turn, arise from age differences in some motivational factors.

Age Differences in Affect Regulation Motivation (Hedonic vs. Eudaimonic Approach)

The potential role of motivation is stressed by two theories that were developed to explain age differences in affective feeling and affect regulation: socioemotional selectivity theory (SST; Carstensen, 2006) and strength and vulnerability integration (SAVI) theory (Charles, 2010). Albeit not equivalent, these two theories both postulate that, with advancing age, future time perception decreases, inducing changes in the fundamental goals individuals are motivated to pursue. Compared with older adults, younger adults are assumed to adopt a more eudaimonic approach to well-being (Ryan & Deci, 2001), focused on their self-development. Young adults see no limits to their future time, leading them to pursue goals that tend to promote their future well-being at the expense of their immediate one (e.g., accumulating new knowledge through education) (Lang & Carstensen, 2002). By contrast, as they become aware of the more limited time they have left to live (Löckenhoff & Carstensen, 2007), older adults adopt a more hedonic approach to wellbeing (Kahneman, Diener, & Schwarz, 1999), focused on the goal of cultivating their immediate well-being.

25 Pursuing this goal appears to lead older adults to use some affect regulation strategies more
26 intensely than younger adults do (Doerwald et al., 2016), as these strategies effectively
27 promote immediate well-being (Charles & Pasupathi, 2003; Pavani, Le Vigouroux, Kop,
28 Congard, & Dauvier, 2015; Röcke, Li, & Smith, 2009). The precise way in which these age
29 differences in motivation lead younger and older adults to differ in the *intensity* with which
30 they implement various affect regulation strategies has received considerable attention (e.g.,
31 Diehl et al., 2014; Diehl, Coyle, & Labouvie-Vief, 1996; Le Vigouroux et al., 2015;
32 Rovenpor, Skogsberg, & Isaacowitz, 2012). By contrast, little is known about how age
33 influences the reactive versus proactive use of affect regulation strategies, even though this
34 construct appears to be key to the effectiveness of affect regulation (Carstensen, Fung, &
35 Charles, 2003; Gross, 1998).

36 **Age Differences in Affect Regulation Timing: Reactive Versus Proactive**

37 Affect regulation can take place either before or after the experience of an affect (Voelkle,
38 Ebner, Lindenberger, & Riediger, 2013). On this basis, Gross (Gross, 1998, 2015; Gross &
39 Thompson, 2007) distinguished between response- and antecedent-focused affect regulation
40 strategies. Response-focused (i.e., reactive) strategies are strategies used in reaction to an
41 affect that is already present, and are designed to modify this elicited affect. Antecedent-
42 focused (i.e., proactive) strategies are strategies that target the antecedents of an affect, and
43 involve modifying the information input before that affect occurs.

44 Gross (1998)'s assumption that some strategies are always reactive (e.g., expressive
45 suppression) whereas others are always proactive (e.g., positive reappraisal) appears to be
46 inaccurate. Indeed, the most recent version of his own model of affect regulation (Gross,
47 2015) stresses the complexity of the dynamics of affect regulation, which is described as a
48 continuum of processes taking place either before, during, or after an affect. Thus, the time at
49 which an affect regulation strategy is used in relation to the targeted affect may be the only

50 criterion for accurately categorizing a strategy as reactive or proactive. In the present study,
51 given that the affects that individuals most often want to modify are high NA and low PA
52 (Riediger, Schmiedek, Wagner, & Lindenberger, 2009), we defined *reactive strategies* as
53 those affect regulation strategies used after a high NA/low PA state. Proactivity is more
54 difficult to assess experimentally, as the targeted affect may never happen if the regulation is
55 successful. Thus, *proactive strategies* cannot be defined as the strategies used before high
56 NA/low PA states. That said, strategies used after low NA/high PA are, by definition, not
57 reactive, and can be regarded as a preventive measure to limit a future increase in NA or
58 decrease in PA.

59 We hypothesized that age differences in motivation would lead younger and older
60 individuals to differ in their use of reactive and proactive affect regulation strategies.
61 Assuming that younger adults are less motivated to cultivate their immediate well-being than
62 older adults, they may only use affect regulation strategies when their well-being has been
63 reduced by unpleasant events, for example (i.e., in a reactive manner). Furthermore, their
64 eudaimonic approach to well-being may precisely expose them to unpleasant events, leading
65 to increasing use of strategies to deal with them. By contrast, if one of the main goals of older
66 adults is to cultivate their immediate well-being, then they may use affect regulation strategies
67 more intensely, not only in reaction to a low level of well-being, but also when its level is
68 already high, for instance in an already pleasant situation (i.e., in a proactive manner).

69 **The Present Study**

70 The aim of this study was to examine age differences in the reactive and proactive use of
71 affect regulation strategies. For the reasons set out above, *reactive regulation* referred to
72 strategies used in response to a high level of NA or low level of PA. By contrast, *proactive*
73 *regulation* referred to strategies used when an individual experiences a low level of NA or
74 high level of PA. The strategies we analyzed were problem solving (i.e., behavioral effort to

75 take concrete actions to change a situation perceived of as unpleasant) and positive
76 reappraisal (i.e., cognitive effort to evaluate a situation that was initially perceived of as
77 unpleasant in a more favorable fashion). We focused on these two strategies because they are
78 widely studied strategies that are known to be effective in enhancing wellbeing (e.g., Pavani
79 et al., 2015), they can be used either proactively or reactively (Blanchard-Fields, Stein, &
80 Watson, 2004; Urry, 2009), and their use changes with age (Doerwald et al., 2016).
81 Innovative use of an experience sampling method (ESM; Hektner, Schmidt, &
82 Csikszentmihalyi, 2008) and refined statistical tools such as generalized additive mixed
83 models (GAMMs; McKeown & Sneddon, 2014) allowed us to test two hypotheses.

84 Our first hypothesis was that older adults use affect regulation strategies (i.e., problem
85 solving and positive reappraisal) more intensely than younger adults. Our second hypothesis,
86 which referred to age differences in strategy timing, was that a) compared with adolescents,
87 young adults use these strategies more intensely reactively, and b) compared with younger
88 adults, older ones use these strategies more intensely proactively. In other words, older adults
89 make intense use of regulation strategies both reactively and proactively.

90 **Method**

91 **Participants**

92 The sample consisted of 209 nonclinical individuals (131 women) ranging in age from 13
93 to 80 years ($M = 38.50$, $SD = 17.56$). It included 39 participants aged 13-20 years, 51 aged
94 21-30 years, 56 aged 31-50 years, 52 aged 51-70 years, and 11 aged 70 years or over.
95 Participants were recruited from the experimenters' social networks, and came from various
96 regions of France. The study met local ethical rules on noninvasive protocols involving
97 healthy participants and did not require formal ethics committee approval. All participants
98 signed an informed consent form, which outlined the conditions for taking part, as well as for
99 withdrawing from the study, if desired.

100 **Procedure**

101 An initial interview was conducted to establish the list of 14 items that participants would
102 subsequently be asked to rate during the ESM phase (for more information, see “Affects and
103 strategies” subsection below). The ESM phase lasted 2 consecutive weeks, during which
104 participants rated the 14 selected items 5 times a day, in response to alerts sent to their mobile
105 phones from a central server. Each participant could adjust the timing of these alerts (usually
106 at 9 am, midday, 3 pm, 6 pm and 9 pm) by up to 15 minutes. After receiving an alert message,
107 they had 30 minutes to respond, using the reply function of their mobile phone. For the affect
108 items, participants were asked to indicate their current level of feeling, whereas for the
109 strategies, the focus was on the level of strategy use since their previous response.
110 Participants responded by texting the numbers corresponding to their ratings for each item¹.

111 Once we had collected all the data, we removed the responses containing errors (e.g.,
112 insertion of a 15th digit in the sequence), duplications and answers that were sent within 2¼
113 hours of the previous or subsequent text message. On average, we received 60 responses to
114 the 70 text messages sent to each participant during the study period (i.e., 86%).

115 **Measures**

116 **Chronological age.**

117 Age appears to be a reliable predictor of individuals’ perceptions of the time they have left
118 to live, with a strong negative correlation ($r = -.70, p < .001$; Lang & Carstensen, 2002).

119 **Affects and strategies.**

¹ For example, one response was “311 142 514 451 43”. The first 12 digits corresponded to the intensity of the 12 affects at the time of the reply. The last two digits corresponded to the levels at which problem solving and positive reappraisal had been used since the previous response.

120 The procedure was identical for affects and strategies. Twelve affect definitions were
121 operationalized on the basis of the 12-point affect circumplex (Yik, Russell, & Steiger, 2011),
122 while problem solving and positive reappraisal were given the definitions that are commonly
123 used in affect regulation research². After the experimenter had read out the definition for an
124 affect or strategy during the initial interview mentioned above, each participant had to
125 summarize this definition by providing what he or she believed to be the most prototypical
126 adjective (for affects) or short sentence (for strategies). This procedure yielded a list of 12
127 adjectives for each participant, corresponding to the 12 affects, and two short sentences
128 describing the two strategies. These 14 elements formed the items that participants rated in
129 the ESM phase on 5-point Likert scales ranging from 1-*Not at all* to 5-*Very felt* (for affects)
130 and used (for strategies). At the end of the interview, to ensure consistency between the
131 adjectives and short sentences chosen by the participants and the target affects and strategies,
132 we submitted each set of items to the participant who had selected them, and asked him or her
133 to restore their meanings. This procedure limited the risk of the same term meaning different
134 things to different participants (Nesselroade, Gerstorf, Hardy, & Ram, 2007).

135 The responses given for the 12 affective items at each assessment were subjected to a
136 principal component analysis (PCA) in order to reduce the number of variables. This PCA
137 revealed that three components could explain a substantial part of the variance (i.e., 64%).
138 The first component was labeled NA, as it saturated the five negatively valenced affects
139 observed in the circumplex model (Yik et al., 2011). The second component was labelled
140 deactivated PA, as it saturated the two deactivated PAs of the model as well as the PA that
141 was neither activated nor deactivated. The third component was labeled activated PA, as it

² See additional material for more information on the definitions given to participants.

142 saturated the two activated PAs of the model, as well as the two activated or deactivated
143 affects that were neutrally valenced.

144 **Statistical Analyses**

145 The data we collected (i.e., the affect experienced by participants and their use of strategies
146 during the ESM phase) formed time series that had to be analyzed using mixed models.
147 However, the nature of these data required more flexible models than generalized linear
148 mixed models (GLMMs; Faraway, 2005). When relationships between variables are more
149 complex than linear ones, as is frequently observed in studies examining the effect of age on
150 affective variables (e.g., Carstensen et al., 2011; Gross et al., 1997; Mroczek & Kolarz, 1998),
151 GAMMs can provide the flexibility needed to properly describe these relationships.
152 Moreover, with GAMMs, analyzing nonlinear interactions between quantitative explanatory
153 variables is easier than analyzing them with polynomial-type transformations within the
154 GLMM framework (Marx & Eilers, 1998; Wood & Augustin, 2010). GAMMs' aim is not to
155 realize tests of differences between specific age groups, but the graphing is used to
156 approximate these effects descriptively.

157 GAMMs implemented with the *mgcv* package (Wood, 2011) in R software (R Core Team,
158 2015) allowed us to examine the relationship between a person's affective state at a given
159 time and any subsequent use of regulation strategies. To assess the moderating effect of age
160 on this relationship, we included use of the two strategies (during the $t.t+1$ interval³) as the
161 variable to be explained, and age as the explanatory variable, considered continuously in
162 interaction with the three affective components: NA, deactivated PA, and activated PA. In
163 order to graphically represent the effect sizes, we carried out these analyses using data
164 standardized on the full sample.

³ The participant's estimated level of strategy use during the $t.t+1$ interval was measured at t_{+1} .

165

Results

166 Descriptive Statistics

167 Our first hypothesis concerned the relationship between the age and strategy variables. The
168 correlations in Table 1 between age and the mean level at which each participant used
169 problem solving and positive reappraisal show that, as hypothesized, use of these two
170 strategies increased with age. Moreover, the correlations between age and mean affect per
171 participant suggested moderate age-related differences in affects of the same order of
172 magnitude as that described in the literature with similar methodologies (Carstensen,
173 Pasupathi, Mayr, & Nesselroade, 2000; Scheibe, English, Tsai, & Carstensen, 2013; Stone,
174 Schwartz, Broderick, & Deaton, 2010). Age was negatively correlated with NA and positively
175 correlated with activated PA, whereas its correlation with deactivated PA failed to reach
176 significance.

177 INSERT TABLE 1 ABOUT HERE

178 Statistical Modeling

179 To study the moderating effect of age on the relationship between affect and the
180 subsequent use of affect regulation strategies (Hypothesis 2), we fitted two GAMMs⁴, with
181 age (interacting with the affects measured at t) as predictor, and the strategies used between t
182 and $t+1$ (i.e., those measured at $t+1$) as response variable. Explained deviance was .06 for
183 problem solving ($edf(\text{age}, \text{NA}_t) = 7.34, p < .001$; $edf(\text{age}, \text{DPA}_t) = 14.19, p < .001$; $edf(\text{age},$
184 $\text{APA}_t) = 14.57, p < .001$) and 0.05 for positive reappraisal ($edf(\text{age}, \text{NA}_t) = 4.98, p < .001$;
185 $edf(\text{age}, \text{DPA}_t) = 11.32, p < .001$; $edf(\text{age}, \text{APA}_t) = 1.00, p < .001$)⁵. In the two models we

⁴ Model structure: $\text{strategy}_{t,t+1} \sim s(\text{age}, \text{NA}_t) + s(\text{age}, \text{DPA}_t) + s(\text{age}, \text{APA}_t) + (1|\text{Participant})$.

⁵ edf = estimated degrees of freedom. A higher edf corresponds to a more complex relationship between the variables.

The indication ‘ $_{t,t+1}$ ’ of each strategy indicates that it is the level of strategy’s use estimated by the individual concerning the $_{t,t+1}$ interval and which is measured at $_{t+1}$.

A higher edf corresponds to a more complex relationship between the variables.

186 calculated, five out of six interactions were nonlinear (*edf* above 1). In order to represent
187 them, we produced a series of predicted value graphs (Fig. 1). Variations ranging from -.3 to
188 .3 standard deviations indicated modest but notable differences.

189 INSERT FIGURE 1 ABOUT HERE

190 Like the correlations reported above, the GAMM results were consistent with our first
191 hypothesis. Older adults used more problem solving and positive reappraisal than younger
192 adults, regardless of the type of affect experienced beforehand.

193 Our second hypothesis was generally confirmed by the results on the use of problem
194 solving. When we considered NA (Fig. 1a), we found that the under-20s made little use of
195 problem solving. Individuals aged 20 years or older used this strategy more intensely when
196 they had previously felt high NA, reflecting an increase in reactive regulation with age. By
197 contrast, we only observed an increase in proactive regulation (i.e., problem solving following
198 low NA) among adults aged 55 years or more. When we considered deactivated PA (Fig. 1c),
199 we found that after the age of 20 years, a low level of deactivated PA increasingly led to a
200 high level of problem solving use, reflecting more intense reactive regulation. By contrast, the
201 proactive use of problem solving (i.e., following high deactivated PA) only started to increase
202 at around 45 years. When we considered activated PA (Fig. 1e), we unexpectedly observed
203 the opposite pattern. Adults aged 20 years or more implemented problem solving more
204 proactively than younger individuals, whereas more intense reactive use of this strategy was
205 only observed among individuals aged 55 years or more.

206 Regarding the use of positive reappraisal, results did not entirely support our hypothesis.
207 As expected, the oldest adults were the ones who used this strategy the most, both reactively
208 and proactively. Moreover, when DPA was considered (Fig. 1d), the hypothesized pattern
209 emerged, insofar as the reactive implementation of positive reappraisal was more intense
210 among adults aged 20 years or more than among younger individuals, whereas the proactive

211 use of this strategy increased mainly among adults aged 55 years or more. However, contrary
212 to what we had predicted, we found similar age-related differences in the proactive and
213 reactive use of positive reappraisal when NA and activated PA were considered (Fig. 1b and
214 Fig. 1f).

215 **Discussion**

216 In summary, our findings confirmed our hypothesis that, compared with their younger
217 counterparts, older adults implement problem solving and positive reappraisal more intensely,
218 both reactively and proactively. This finding is consistent with the idea that, as older adults
219 are more motivated to promote their immediate well-being than younger adults, owing to their
220 perception of the reduced time they have left to live, they engage more in the implementation
221 of affect regulation strategies (Carstensen, 2006; Charles, 2010).

222 Furthermore, when we analyzed age-related differences in strategy use following
223 experiences of NA and deactivated PA, we observed the hypothesized pattern of differences
224 between reactive and proactive regulation. Participants aged 20 years or more implemented
225 problem solving more intensely and in a reactive manner, probably owing to their eudaimonic
226 approach to wellbeing. By contrast, probably owing to the more hedonic approach to
227 wellbeing displayed by older adults, an increase in the proactive use of this strategy was only
228 observed among individuals aged 55 years or more. An equivalent increase was observed in
229 the proactive use of positive reappraisal following the experience of deactivated PA, but its
230 reactive and proactive uses underwent similar age-related changes whatever the previous level
231 of NA or activated PA.

232 When we considered strategy use following activated PA, age-related differences in
233 reactive regulation no longer preceded age-related differences in proactive regulation. One
234 possible explanation for this result is that affects are not simply signals triggering regulation
235 activities; they also serve as regulation resources (e.g., Fredrickson, 1998). In particular,

236 activated PA may be a useful source of energy for individuals who are less motivated to
237 achieve immediate well-being (i.e., younger adults), as it may make the use of costly affect
238 regulation strategies (e.g., problem solving) easier. By contrast, individuals who are more
239 motivated to achieve immediate well-being (e.g., older adults) may engage in such strategies
240 even when they experience low energy states. In short, if activated PA constitutes a resource,
241 we can assume that young adults use the energy as and when it is available, while older adults
242 engage in strategies such as problem solving even when they lack energy, potentially with the
243 aim of regaining it in the future.

244 The first limitation of our study was the indirect operationalization, based on previous
245 affective states, of reactive and proactive affect regulation. Our results therefore need to be
246 validated using another procedure that more straightforwardly operationalizes the difference
247 between proactive and reactive regulation. For example, participants could be directly
248 questioned about their approach to regulation: do they use each of the strategies according to
249 their previous affective state or according to the affective state they may experience in the
250 future?

251 A second limitation is that we included only a few very old adults, owing to the nature of
252 the protocol. This is important, as affective experience has been shown to change in extreme
253 old age. It would be interesting to see whether very old people, who exhibit a decline in well-
254 being (Gana, Saada, & Amieva, 2015), continue to use proactive regulation. A last limitation
255 of this study refers to use of convenience/social network-based sampling.

256 In conclusion, our analyses yielded evidence of distinct age differences in the reactive
257 versus proactive use of two affect regulation strategies that enhance well-being. Compared
258 with the under-20s, adults aged 20 years or more used the strategies we focused on more
259 intensely and in a reactive manner. More intense proactive use of these strategies was
260 observed solely in older participants, from around 55 years upwards, and solely when strategy

261 use following NA or deactivated PA. The opposite pattern emerged following activated PA.
262 Although we interpreted our findings in the light of motivational factors (i.e., age differences
263 in eudaimonic vs. hedonic approaches to well-being), these findings need to be replicated and
264 further explained.

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107

108 **Table and Figure**

109 Table 1

110 *Correlations Between Age, Affective Components and Regulation Strategies*

	Age	NA	DPA	APA	PS	PR
NA	-.17*	1				
DPA	.04	-.34** -.43 (.32)	1			
APA	.16*	-.06 -.39 (.28)	.53** .10 (.32)	1		
Problem solving	.19*	.19** .03 (.20)	.33** -.05 (.19)	.52** .05 (.19)	1	
Positive reappraisal	.16*	.16* .02 (.22)	.43** -.01 (.22)	.43** .05 (.19)	.63** .26 (.26)	1

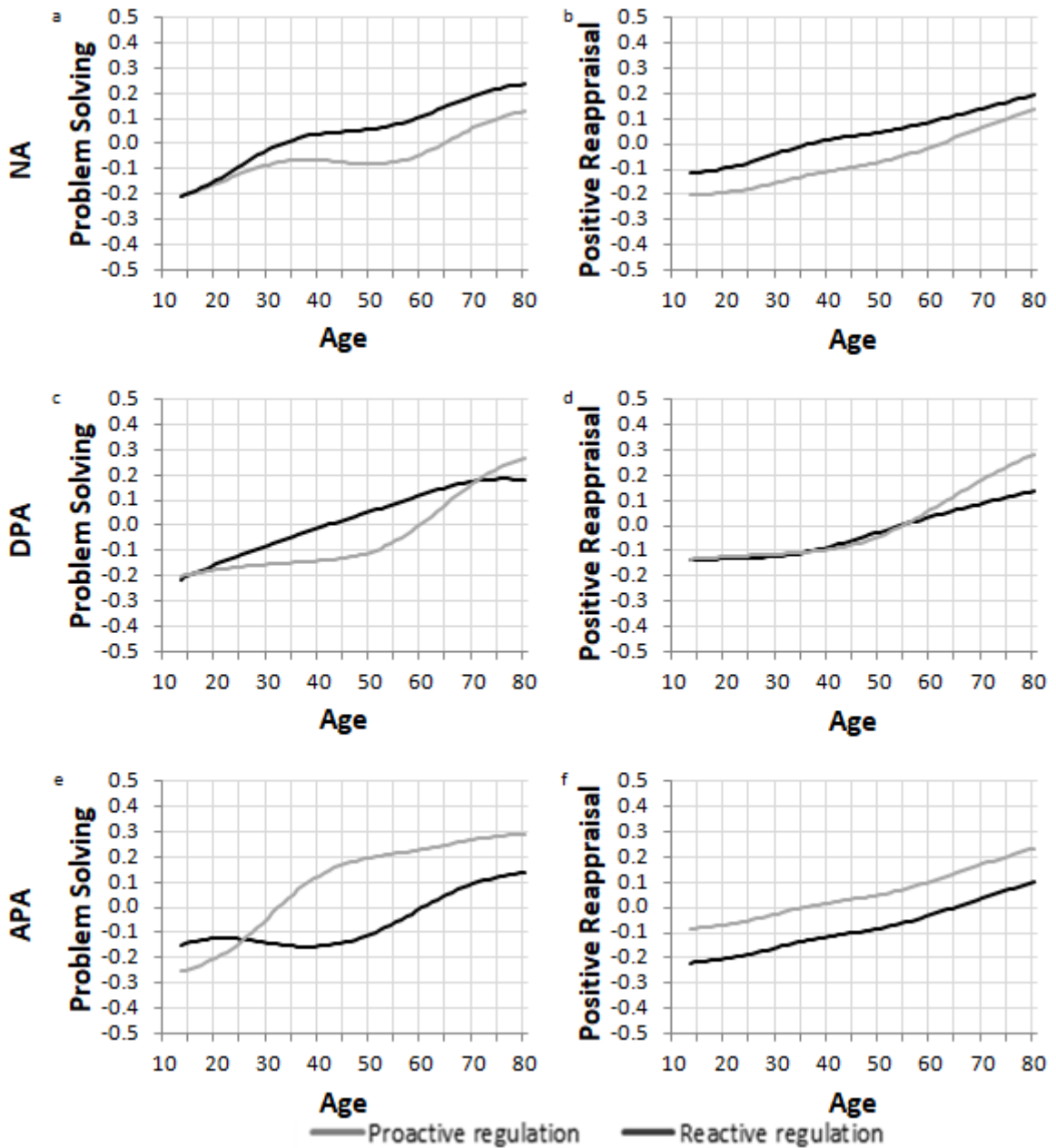
* $p < .05$, ** $p < .01$.

Note. NA = negative affect; APA = activated positive affect; DPA = deactivated positive affect; PR = positive reappraisal; PS = problem solving. First row: interindividual correlations with mean individual levels of affective components and regulation strategies. Second row: mean (standard deviation) intra-individual correlations.

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115 *Note.* NA = negative affect; APA = activated positive affect; DPA = deactivated positive affect.
 116 *Reactive regulation* corresponds to the use of strategies following a period of reduced well-being
 117 (high NA / low APA and/or DPA). *Proactive regulation* corresponds to the use of strategies
 118 following a period of high wellbeing (low NA / high APA and/or DPA). The level of strategy use
 119 was standardized. For each graph, the predicted values were estimated for a value of ± 1 standard
 120 deviation for the relevant affective component, while the other two affective components were set
 121 at the mean (means and standard deviations computed on all observations). The black (reactive)
 122 curve corresponds to +1 SD of NA or -1 SD of DPA and APA. The grey (proactive) curve corresponds to
 123 -1 SD of NA or + 1 SD of DPA and APA.

124 *Figure 1.* Generalized additive mixed model predictions for the proactive versus reactive
125 use of cognitive reappraisal and problem solving for affect regulation, in interaction with age.