

Do exercisers maximize their pleasure by default? Using prompts to enhance the affective experience of exercise

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4 Do exercisers maximize their pleasure by default? Using prompts to enhance the affective
5 experience of exercise
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Abstract

36
37 Researchers and practitioners are increasingly recognizing the importance of maximizing
38 pleasure during exercise in order to promote exercise behavior. Self-selected intensity exercise
39 can increase pleasure during exercise, but it is not yet known whether participants maximize
40 pleasure during self-selected intensity exercise by default. We hypothesized that prompting
41 participants to maximize pleasure and enjoyment would result in more positive affective valence
42 during (H1) and after (H2) exercise, greater remembered pleasure following exercise (H3), and
43 greater enjoyment of exercise (H4). In this within-subjects experiment, 39 inactive adults
44 completed two 10-min stationary cycling sessions at a self-selected intensity. During the
45 experimental condition, participants were reminded (five times during the 10-min session) to
46 maximize pleasure and enjoyment, and that they could change the intensity if they wanted.
47 Affective valence, heart rate, and ratings of perceived exertion were measured every two minutes
48 during exercise. Affective valence, enjoyment, and remembered pleasure were measured after
49 each exercise session. The control condition was identical, except no prompts were provided.
50 Each hypothesis was supported ($p < .05$). Prompting participants to maximize their pleasure and
51 enjoyment resulted in increased pleasure as the exercise session progressed. After receiving
52 prompts, participants also reported more positive post-exercise affective valence and rated the
53 session as more pleasant and enjoyable. These results suggest that participants do not maximize
54 pleasure and enjoyment by default (i.e., in the absence of reminders to do so). Researchers can
55 build on these results to determine the mechanisms and whether prompting exercisers to
56 maximize pleasure and enjoyment can promote exercise behavior.

57 **Keywords:** affective valence, affective responses, prompting, self-selected intensity
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59

60 Most adults in Western countries, including the USA (Troiano et al., 2008; Tudor-Locke,
61 Brashear, Johnson, & Katzmarzyk, 2010) and Canada (Colley et al., 2011; Liu, Wade, Faught, &
62 Hay, 2008) are insufficiently active. The societal burden of such inactivity has also been well
63 documented (Kohl, et al., 2012; Lee et al., 2012). Thus, innovative strategies for improving rates
64 of physical activity behavior are needed.

65 Hedonic theory, or the theory of psychological hedonism, suggests that people repeat
66 activities that feel pleasurable and avoid activities that elicit displeasure (Ekkekakis, 2009).
67 Applied to the context of exercise, hedonic theory suggests that maximizing pleasure
68 experienced during exercise would enhance future exercise behavior (e.g., Ekkekakis, Vazou,
69 Bixby, & Georgiadis, 2016). Indeed, mounting evidence suggests that the degree of pleasure
70 experienced during exercise is meaningfully predictive of future exercise behavior (for review
71 see Rhodes & Kates, 2015; Williams, Dunsiger, Jennings, & Marcus, 2012). Theorists have
72 argued that the pleasure experienced during exercise can influence automatic associations with
73 exercise, such as the tendency to automatically approach or avoid physical activity (Ekkekakis &
74 Dafermos, 2012; Ekkekakis & Zenko, 2016) and that these automatic associations influence
75 behavior (Brand & Ekkekakis, 2018). Therefore, empirical evidence and theoretical justifications
76 exist for maximizing the pleasure of exercise in an effort to promote long-term adherence.

77 Behavioral decisions are often based on predictions of the hedonic consequences of
78 future events; such predictions draw heavily upon the retrospective evaluation of the pain or
79 pleasure associated with past episodes, a concept known as *remembered utility* in the field of
80 behavioral economics (Kahneman et al., 1997; Oliver, 2016). Consequently, maximizing the
81 level of pleasure and enjoyment associated with an exercise experience may enhance future
82 exercise behavior.

83 Evidence suggests that the memory of an experience is not simply determined by the
84 average level of pleasure or displeasure felt during the experience, but by certain highly
85 influential moments of an experience, such as the “peak” (highest or lowest levels of pleasure or
86 displeasure) and the end of an experience (Kahneman, Wakker, & Sarin, 1997; Redelmeier &
87 Kahneman, 1996; Schreiber & Kahneman, 2000; Zenko, Ekkekakis, & Ariely, 2016). Thus,
88 moment-to-moment recordings of pleasure might not accurately reflect how an exercise
89 experience registers in memory and influences a person’s predictions of how pleasurable or
90 unpleasant future exercise will be. Instead, asking participants to report how pleasurable they
91 remember the exercise session to be may be important for predicting future exercise behavior.

92 During self-selected or self-paced exercise, the exercise intensity is determined by the
93 exerciser – not prescribed by another person (e.g., personal trainer, researcher, practitioner).
94 Previous reviews have indicated that, with some exceptions, most individuals self-select
95 intensities that are associated with physiological benefits (Ekkekakis, 2009). Self-selected
96 exercise intensity has been linked to enhanced autonomy, interest/enjoyment, and perceived
97 choice (Hutchinson et al., 2018; Vazou-Ekkekakis & Ekkekakis, 2009). Further, exercise
98 programs consisting of self-selected exercise intensities have been shown to result in greater
99 exercise adherence and greater energy expenditure, compared to prescribed moderate-intensity
100 exercise programs (Williams et al., 2015). The greater exercise adherence is at least partly due to
101 more positive affective responses to self-selected exercise (Williams et al., 2016).

102 Although self-selected intensities can result in positive affective responses to exercise
103 (Haile, Goss, Andreacci, Nagle, & Robertson, 2019; Sheppard & Parfitt, 2008), people may not
104 optimize their exercise for maximum pleasure by default. One reason is that people may not
105 intuitively understand how to increase pleasure experience during exercise. Even when

106 intensities are not imposed, participants may not intuit the relation between exercise intensity and
107 pleasure that has been reported in previous research (Ekkekakis, Parfitt, & Petruzzello, 2011).
108 Further, oft-repeated phrases such as “no pain, no gain” and “go for the burn” may have
109 influenced the attitudes and beliefs of the general public (Slotterback, Leeman, & Oakes, 2006).
110 In other words, the general public may have the goal of “burning calories” during exercise but
111 not maximizing pleasure. One of the goals of this study was to determine if people optimize their
112 exercise experience for pleasure by default.

113 Reminders or prompts at behavioral decision points (e.g., deciding whether or not to go
114 to the gym at all, or deciding to engage in vigorous- vs. low-intensity exercise once at the gym)
115 could not only prompt people to be more active (Russell & Hutchinson, 2000), but also help
116 them maximize their pleasure and enjoyment when doing so. Reminders or prompts at decision
117 points have been found to yield improvements in behavior in the medical (e.g., Shojania et al.,
118 2010; Tang, LaRosa, Newcomb, & Gorden, 1999), financial (e.g., Karlan, McConnell,
119 Mullainathan, & Zinman, 2016), dietary (e.g., Papies & Veling, 2013), and physical activity
120 (e.g., Schwerdtfeger, Schmitz, & Warken, 2012) domains.

121 Using prompts to maximize pleasure and enjoyment may make the goal of exercising for
122 pleasure and enjoyment more salient than it would be by default, in a situation without prompts.
123 Research shows the importance of incorporating periodic or persistent reminders to increase goal
124 salience (e.g., Fry & Neff, 2009). A relevant example might be Thaler and Sunstein's (2008)
125 concept of “nudge” which describes attempts to influence behavior in a predictable way but
126 without restricting choice. In health care settings, nudges can be designed to remind, guide, or
127 motivate behavior (Patel et al., 2018). In the present study, we manipulated the salience of

128 maximizing pleasure and enjoyment to determine if it would have any effect on the affective
129 experience of exercise.

130 The purpose of the current study was to determine (i) if people optimize their exercise
131 experience for pleasure by default and (ii) if prompts to maximize pleasure and enjoyment during
132 exercise could result in greater experienced pleasure during and after exercise, greater
133 remembered pleasure about the exercise session, and more enjoyment of the exercise session.
134 We hypothesized that prompting participants to maximize pleasure and enjoyment would result
135 in more positive affective responses during exercise (H1), higher postexercise affective valence
136 (H2), greater remembered pleasure of exercise (H3), and more remembered enjoyment of
137 exercise (H4).

138 Prior reviews indicate that at lower exercise intensities, especially below the ventilatory
139 threshold, most people experience pleasure; in contrast, higher exercise intensities (above the
140 ventilatory threshold) are associated with reduced levels of pleasure (Ekkekakis et al., 2011).
141 Therefore, this study was also designed to explore whether participants would also decrease self-
142 selected exercise intensity in response to reminders about maximizing their pleasure. Decreases
143 in self-selected exercise intensity might help explain underlying mechanisms for increases in
144 pleasure and enjoyment. As this analysis was exploratory in nature, no *a priori* hypotheses were
145 set in relation to the intensity-related variables of heart rate (HR) and ratings of perceived
146 exertion (RPE).

147 **Methods**

148 **Recruitment and Participants**

149 Recruitment began after ethics approval by an institutional review board. A power
150 analysis indicated that to achieve 80% statistical power with a Type 1 error rate of 5% (two-

151 sided), anticipating a medium effect size ($d = .5$), at least 34 participants would be required for a
152 paired-samples t -test. To account for potential dropout or participant deletion, the sample size
153 was inflated by 20% to 41. Therefore, we aimed to recruit 41 participants to the present study. A
154 pre-study demographics questionnaire was sent to participants via email to obtain information
155 about gender, age, body mass index (BMI), race and ethnicity, and status as a current student at
156 the university.

157 Potential participants were recruited using an electronic participant recruitment platform
158 (SONA system) of a large university on the East Coast of the United States, which includes
159 members of the university and local community. Participants were screened for study eligibility
160 based on two criteria. First, we specifically recruited insufficiently active participants to ensure
161 that the study findings would be applicable to populations in particular need of novel
162 intervention strategies. Participants were asked, “How many minutes of moderate-to-vigorous
163 exercise do you usually obtain per week?” and were eligible if they obtained fewer than 60
164 minutes of moderate-to-vigorous exercise per week, to ensure that they were not meeting the
165 physical activity guidelines (Garber et al., 2011). Second, participants completed the Physical
166 Activity Readiness Questionnaire (PAR-Q; Adams, 1999) to assess whether it was safe to engage
167 in a physical fitness task; any participant who answered affirmatively to any of the PAR-Q
168 questions was excluded from the study. Eligible participants then scheduled two laboratory
169 visits.

170 In total, 121 people completed the screening form. Four people were excluded due to
171 affirmative answers on the PAR-Q, 28 were excluded because they reported 60 or more minutes
172 of moderate-to-vigorous exercise per week, and 48 were eligible but did not schedule laboratory
173 visits. Forty-one participants consented and attended at least one laboratory visit. Of these

174 participants, 85.4% completed the prestudy demographics questionnaire and reported the
175 following demographics: 63.6% women, 36.4% men; age: 32 ± 10 years; BMI: 27.37 ± 9.31
176 $\text{kg} \cdot \text{m}^{-2}$; 30.3% White, 27.3% Black or African American, 21.2% Asian, 15.2% Multiracial, 6.1%
177 Latino; 39.4% students. A total of 39 participants completed the study.

178 **Measures**

179 **During-exercise measures.**

180 *During-exercise affective valence.* Affective valence was conceptualized as a bipolar
181 dimension ranging from pleasure to displeasure (Russell, 1980). Affective valence was measured
182 at baseline and during exercise using the Feeling Scale (FS; Hardy & Rejeski, 1989). The FS is a
183 single-item, 11-point, bipolar rating scale that ranges from -5 (Very Bad) to +5 (Very Good) with
184 zero serving as a neutral point. The FS allows affective valence to be assessed repeatedly during
185 exercise for strong temporal resolution yet minimal participant burden. Concurrent validity data
186 have been reported by Hardy and Rejeski (1989).

187 *Heart rate.* A heart rate (HR) monitor was worn around the chest to continuously
188 measure heart rate during exercise (Polar, Kempele, Finland). Heart rate was quantified as a
189 percentage of age-predicted maximum heart rate (APMHR; $220 - \text{age in years}$). Heart rate was
190 recorded using the Polar Beat app and participants could not see their heart rate before, during, or
191 after exercise.

192 *Perceived exertion.* Ratings of perceived exertion were assessed using Borg's (1998)
193 RPE scale. The scale ranges from 6 (no exertion at all) to 20 (maximal exertion). RPE has
194 correlated with several indices of physiological exertion, including ventilation and lactate
195 accumulation (Chen, Fan, & Moe, 2002).

196 **Postexercise measures.**

197 *Postexercise affective valence.* The Feeling Scale (FS) was administered two minutes
198 following exercise to assess self-reported pleasure following the exercise session. Practical time
199 constraints in the laboratory, as well as the theoretical consideration that postexercise affective
200 valence has not been linked with future exercise behavior (Rhodes & Kates, 2015), resulted in
201 only one measurement of postexercise affective valence.

202 *Remembered enjoyment.* Enjoyment of exercise was assessed using the Physical Activity
203 Enjoyment Scale (PACES; Kendzierski & DeCarlo, 1991). Respondents were asked, “Rate how
204 you feel at the moment about the physical activity you have been doing.” The PACES consists of
205 18 bipolar items with verbal anchors at both ends of the 7-point scale (with “4” as a midpoint).
206 Internal consistency of the PACES in the present sample was high following both exercise
207 sessions (Cronbach’s $\alpha = .92, .92$).

208 *Remembered pleasure.* Remembered pleasure was assessed following exercise. Using a
209 computer monitor, an on-screen bipolar visual analog scale, with values from 0 to 100, was
210 shown to participants with the question “How did you feel during today’s exercise session?”
211 Verbal anchors (ranging from “It was a very negative experience” to “It was a very positive
212 experience”) were provided at the extremes of the scale. Participants could move the slider to
213 any point of the scale but were not shown the numerical values associated with the position or
214 either of the verbal anchors. This measure was chosen in order to minimize common-method
215 variance by using a different scale than the FS. Remembered pleasure has been assessed
216 similarly in previous investigations (e.g., Zenko, Ekkekakis, & Ariely, 2016).

217 **Procedures**

218 **Laboratory visits.** Each participant completed two laboratory visits that were scheduled
219 one week apart at the same time of day and on the same day of the week, to account for potential
220 diurnal variation in the dependent variables. Participants provided informed consent at the
221 beginning of their first laboratory visit. The two laboratory visits each consisted of a 10-min
222 cycle bout completed under two conditions (experimental and control) with an order that was
223 randomly assigned.

224 Prior to the start of exercise, each participant was fitted with a heart rate monitor.
225 Standardized instructions for the FS and RPE were read to participants, followed by an
226 opportunity to ask questions. In both conditions, all participants exercised at a self-selected
227 intensity in a laboratory setting for 10 minutes on a cycle ergometer (Schwinn 170 Upright Bike,
228 Shwinn, Vancouver, WA, USA). There was no designated warm-up or cool-down to avoid
229 implicitly or explicitly suggesting reduced intensities and to allow participants to choose their
230 own intensity without restrictions. Participants received instructions on how to change ergometer
231 resistance using the up and down arrows on the ergometer control panel. The display screen,
232 which showed ergometer resistance, was hidden from participant view. The laboratory was free
233 from distraction and participants exercised in the presence of one researcher. The FS was
234 administered one minute prior to exercise, every two minutes during exercise, and two minutes
235 postexercise. HR and RPE were measured every two minutes during exercise (i.e., minutes 1:45,
236 3:45, 5:45, 7:45, and 9:45). The measurements were taken within the last 15 seconds of each
237 two-minute interval to ensure that data were collected while participants were still exercising.
238 Following the exercise bout, participants sat quietly for five minutes prior to completing a
239 questionnaire with measures of remembered enjoyment (PACES) and remembered pleasure.

240 **Conditions.** The conditions differed based on the instructions given immediately before
241 exercising and whether additional prompts to maximize pleasure were provided during exercise:

242 *Control condition.* A researcher read the following instructions to participants in the
243 control condition prior to exercising:

244 For today’s exercise session, you will be exercising on a bike for 10 minutes. I’ll be
245 asking you questions about how you feel and how hard you perceive the work to be. I’ll
246 also be measuring your heart rate. The exercise intensity that you choose is up to you. Do
247 you have any questions?

248
249 Participants were able to change their intensity at will, but no reminder was given.

250 *Prompt condition.* In the prompt condition, the instructions were modified to remind
251 participants that they could change their intensity and maximize their pleasure:

252 For today’s exercise session, you will be exercising on a bike for 10 minutes. I’ll be
253 asking you questions about how you feel and how hard you perceive the work to be. I’ll
254 also be measuring your heart rate. The exercise intensity that you choose is up to you.

255
256 Sometimes people feel most pleasant when working harder, and sometimes people feel
257 most pleasant when exercising at a lower intensity. Other times, people feel best when
258 changing their intensities. Today, I want you to focus on maximizing your pleasure.
259 You’ll be reminded throughout the exercise session to refocus on your exercise intensity
260 and make sure that it makes you feel the most pleasant imaginable. If it requires changing
261 the intensity, then you should make an adjustment to maximize your pleasure. Do you
262 have any questions?

263
264 As in the Control condition, participants could self-select and change the exercise
265 intensity at will. However, a simple prompt was given after every measurement of HR, FS, and
266 RPE. Participants were told, “Remember to maximize your pleasure and enjoyment. You may
267 change the exercise intensity if you wish.”

268 **Data Screening and Statistical Analysis**

269 To test H1, changes in affective valence (i.e., FS ratings) were assessed using a 2
270 (condition) x 6 (time) repeated-measures ANOVA. The six time points were the pre-exercise

271 measure and the five during-exercise measurements. Differences in postexercise affective
272 valence (H2), remembered pleasure (H3), and remembered enjoyment (H4) were assessed using
273 paired *t*-tests. To explore potential causal mechanisms, differences in HR were assessed using a 2
274 (condition) by 6 (time) repeated-measures ANOVA. Pre-exercise HR and HR at each of the five
275 during-exercise measurements were analyzed. Likewise, a 2 (condition) x 5 (time) repeated-
276 measures ANOVA was used to assess differences in RPE, using the five during-exercise
277 measurements.

278 Data were inspected for parametric assumptions using visual inspection of histograms.
279 Affective data, heart rate, and perceived exertion were screened for outliers using standardized *z*-
280 scores ($z > \pm 3.29$; Bird, Karageorghis, Baker, & Brookes, 2019; Tabachnick & Fidell, 2013).
281 One participant presented an abnormally low HR during minute 4 of the Prompt condition ($z = -$
282 4.06), likely due to temporary signal disruption or equipment displacement. This participant's
283 data was eliminated from subsequent analyses involving HR, as is recommended in the case of
284 error outliers (Leys, Delacre, Mora, Lakens, & Ley, 2019). Results and conclusions were similar
285 regardless of inclusion or exclusion. A different participant reported extremely low perceived
286 exertion during minute 4 of the Control condition ($z = -3.32$), but this was likely due to inherent
287 measurement error of subjective reports, and the participant's responses were consistent across
288 time. Thus, this participant's data were retained in the analyses. Again, results and conclusions
289 were similar regardless of inclusion or exclusion. In all cases, violations of the sphericity
290 assumption were corrected using the Greenhouse-Geisser correction. Follow-up tests were
291 performed with paired *t*-tests. When the assumptions of paired *t*-tests were violated,
292 nonparametric alternatives are additionally reported to assist in interpretation. Means and
293 standard deviations for all variables and each condition are presented in Table 1.

Results

294
295
296

Affective valence. A repeated-measures ANOVA (2 [condition] x 6 [time]) with affective valence pre- and during-exercise as a dependent variable indicated no significant effect of condition, $F(1, 38) = 3.10, p = .086, \eta_p^2 = .08$, and no significant effect of time, $F(2.82, 107.32) = 0.73, p = .530, \eta_p^2 = .02$. There was, however, a significant interaction between condition and time, $F(3.17, 120.34) = 3.21, p = .023, \eta_p^2 = .08$, such that affective responses in the Prompt condition became more positive as time progressed. Affective valence data is displayed in Table 1 and Figure 1.

303 Follow-up analyses using paired *t*-tests to compare affective valence between conditions
304 indicated that differences in affective valence began to emerge during minute six (see Figure 1).
305 Only the differences during minutes 6, 8, and 10 approached or reached significance ($t(38) =$
306 $.314, .200, 1.04, 3.01, 1.97, \text{ and } 2.11$, respectively; $ps = .755, .843, .303, .005, .056, \text{ and } .042$,
307 respectively; $ds = .05, .03, .16, .48, .32, \text{ and } .34$, respectively). Small-to-medium differences
308 (Cohen, 1988) were apparent in minutes 6, 8, and 10 ($ds = .32 - .48$).

309 **Postexercise affective valence.** Affective valence was significantly higher following the
310 Prompt condition, compared to the Control condition (Table 1; $t(38) = 2.25, p = .030, d = .36$).
311 Because these data were nonnormal, a Wilcoxon signed-rank test was also used and
312 demonstrated that affective valence was significantly higher following the Prompt condition,
313 compared to the Control condition, showing agreement with the parametric test ($Z = 2.125, p =$
314 $.034$).

315 **Remembered enjoyment.** Enjoyment was significantly greater following the Prompt
316 condition than the Control condition, (Table 1; $t(38) = 2.38, p = .023, d = .38$).

317 **Remembered pleasure.** Remembered pleasure was significantly more positive following
318 the Prompt condition than the Control condition (Table 1; $t(15) = 2.57, p = .022, d = .64$).
319 Notably, less than half of the sample responded to the measure of remembered pleasure,
320 indicating that they may not have fully understood how to respond to the on-screen slider.

321 **Heart rate.** The repeated-measures ANOVA (2 [condition] x 6 [time]) with HR pre- and
322 during-exercise as a dependent variable indicated no significant effect of condition, $F(1, 37) =$
323 $1.02, p = .319, \eta_p^2 = .03$, a significant effect of time, $F(1.60, 59.32) = 127.22, p < .001, \eta_p^2 = .78$,
324 and no significant interaction between condition and time, $F(2.85, 105.29) = 0.57, p = .630, \eta_p^2 =$
325 $.02$. Analysis of within-subject contrasts indicated that the quadratic change in HR over time
326 explained the most variance ($\eta_p^2 = .83$). HR data are displayed in Table 1 and Figure 2. Mean HR
327 during the Prompt condition was 66.75% of APMHR. During the Control condition, HR
328 averaged 68.17% APMHR. Both of these are within the range recommended by the American
329 College of Sports Medicine for moderate-intensity physical activity (Garber et al., 2011).

330 **Perceived exertion.** The repeated-measures ANOVA (2 [condition] x 5 [time]) with RPE
331 as a dependent variable indicated no significant effect of condition, $F(1, 38) = 1.60, p = .214, \eta_p^2$
332 $= .04$, a significant effect of time, $F(2.25, 30.19) = 10.94, p < .001, \eta_p^2 = .224$, and no significant
333 interaction between condition and time, $F(2.08, 5.75) = 2.20, p = .116, \eta_p^2 = .06$. Analysis of
334 within-subject contrasts indicated that the linear change in RPE over time explained the most
335 variance ($\eta_p^2 = .28$). RPE data are displayed in Table 1 and Figure 3.

336 **Discussion**

337 This study was designed to examine whether prompts to maximize pleasure and
338 enjoyment during exercise would enhance affective responses to exercise. Forty-one

339 insufficiently active participants were recruited and 39 completed the study. The participants
340 completed two exercise sessions to determine if a session with prompts to maximize pleasure,
341 increase enjoyment, and change the intensity “if [they] wish[ed]” would result in differences in
342 affective valence, remembered pleasure, enjoyment, and postexercise pleasure. We hypothesized
343 that affective valence during and following exercise, remembered pleasure, and remembered
344 enjoyment would be enhanced by prompts to maximize pleasure.

345 Our hypotheses were supported. Participants experienced more pleasure over time during
346 the Prompt condition compared to the Control condition (H1). They also experienced greater
347 postexercise pleasure following the Prompt condition, compared to the Control condition (H2).
348 In addition, participants remembered the Prompt condition as more pleasurable (H3) and more
349 enjoyable (H4) than the Control condition. While the pleasure experienced immediately
350 following exercise has not been linked to future exercise behavior, a systematic review by
351 Rhodes and Kates (2015) suggests that the greater pleasure experienced *during* exercise may
352 increase future exercise participation. Further, the present study indicates that enjoyment and
353 remembered pleasure – both retrospective evaluations and theoretical predictors of whether
354 exercise should be repeated or avoided (Kahneman, Wakker, & Sarin, 1997; Zenko, Ekkekakis,
355 & Ariely, 2016) – can be enhanced with verbal prompts to maximize pleasure during exercise.

356 **Prompts Enhance Affective Valence**

357 Differences in affective valence between conditions reached or approached statistical
358 significance during the latter-half of the exercise session (minutes 6, 8, and 10), with small-to-
359 medium effect sizes. The actual difference in FS responses ranged, on average, between 0.64
360 units and 0.69 units during minutes 6, 8, and 10. We do not know the practical meaning of these
361 results for the present study. Researchers have linked a one-unit difference in FS responses

362 during exercise to a change of 15 minutes per week of physical activity longitudinally (Williams
363 et al., 2012). This prior evidence suggests that the differences observed in the present study
364 might be associated with several additional minutes of physical activity per week. However,
365 there are several important differences between the present study and the previous research by
366 Williams and colleagues (2012), which makes direct comparison difficult. First, the present
367 study was experimental, whereas the study by Williams and colleagues measured affective
368 responses to treadmill walking between 2 and 4 miles per hour, with no experimental
369 manipulation related to altering intensity or maximizing pleasure. Second, the association
370 between a one-unit difference on the FS and future physical activity was found in a between-
371 subjects analysis in the research by Williams et al. (2012). Here, we observed differences
372 ranging from 0.64 units to 0.69 units in a within-subjects design. Third, there may have been
373 ceiling effects of increased pleasure associated with prompts, since the control condition in the
374 present study also consisted of self-selected exercise intensity. Previous literature has shown that
375 self-selected exercise intensity is associated with pleasant affective responses (Haile et al., 2019;
376 Lind, Ekkekakis, & Vazou, 2008; Sheppard & Parfitt, 2008). Thus, it is reasonable to expect
377 smaller differences in the present study. Taken together, the evidence provided by Williams et al.
378 (2012) suggests that the increase in affective valence observed in the present study may result in
379 increased exercise behavior; however, methodological differences prevent direct comparison.
380 Future researchers would need to measure exercise adherence to determine if prompts to
381 maximize pleasure and enjoyment result in increased exercise behavior.

382 Importantly, the magnitude of the condition differences in affective valence grew as time
383 progressed. These results suggest that participants do not automatically maximize their pleasure
384 and enjoyment by default (i.e., without additional reminders to do so) and that pleasure prompts

385 may have the greatest impact on during-exercise affective valence during the middle and latter
386 half of a short exercise session. More research is needed to determine whether or not the benefits
387 of pleasure prompts are greater during longer bouts of exercise (e.g., 30 minutes or one hour).

388 **Potential Causal Mechanisms**

389 Although the experimental manipulations altered participants' affective experience of
390 exercise, these effects were not due to differences in exercise intensity. RPE and HR did not
391 differ significantly between conditions. Thus, we are unable to attribute the differences in
392 experienced pleasure, postexercise pleasure, remembered pleasure, and remembered enjoyment
393 to differences in intensity, as indicated by HR and RPE. This finding was an unexpected, given
394 the theoretical link between pleasure and intensity described previously (for review, see
395 Ekkekakis et al., 2011). On the other hand, the self-selected nature of the intensity in the present
396 study may explain the lack of difference between conditions. Ekkekakis (2009) noted that most
397 individuals choose an intensity that is associated with physiological benefits and, "(at least in the
398 presence of an investigator), most individuals raise their intensity up to the highest level that
399 permits the maintenance of a positive affective steady state" (p. 879). Indeed, participants in the
400 present study chose an intensity within the range recommended by the American College of
401 Sports Medicine (i.e., 64-76% maximum heart rate corresponds to "moderate-intensity"; Garber
402 et al., 2011), regardless of condition. In short, participants chose intensities that could elicit
403 meaningful physiological benefits while still allowing for a positive affective experience. This
404 finding could address concerns that prompting exercisers to maximize pleasure and enjoyment
405 would result in exercise intensity that is "too light" and not likely to be health-enhancing.

406 Differences in perceived control and autonomy may explain why the Prompt condition
407 altered participants' affective experience compared to the Control condition, without altering

408 participants' self-selected exercise intensity. It is possible that the Prompt condition induced a
409 greater sense of autonomy by reminding participants that they could change their exercise
410 intensity. Increased perceived control and autonomy could have resulted in greater remembered
411 pleasure, enjoyment, and postexercise pleasure. Vazou-Ekkekakis and Ekkekakis (2009) found
412 that allowing participants to self-select their own intensity resulted in greater perceived
413 autonomy and improved energetic arousal (but not greater affective valence as measured using
414 the FS, the same dimensional measure used in the present study). In the present study, however,
415 we did find that reminding participants that they could change the exercise intensity resulted in
416 greater affective valence, potentially highlighting the important role of reminders in increasing
417 pleasure. Methodological differences between the present study and Vazou-Ekkekakis and
418 Ekkekakis (2009) leave open the possibility that reminding participants of their control over self-
419 selected intensities (rather than simply allowing participants to choose their intensity in the
420 absence of reminders) may impact feelings of pleasure-displeasure. However, lack of
421 measurement of perceived control and autonomy in the present study makes it difficult to
422 attribute the more positive affective experience of the Prompt condition to differences in
423 autonomy and perceived control. These potential mechanisms can be explored by future
424 researchers.

425 Limitations of the study design may also explain the effects of the experimental
426 manipulations. For instance, the experimenter interacted with participants in the Prompt
427 condition more frequently than in the Control, in order to deliver the reminders to maximize
428 pleasure and enjoyment. Previous research has shown that frequency of social interaction is
429 positively related to affect (Berry & Hansen, 1996). Therefore, it is possible that increased social
430 interaction could explain some of the observed differences in pleasure and enjoyment between

431 conditions. Future researchers can address this limitation by using pre-recorded audio reminders
432 without depending on human interaction. Likewise, future researchers can control for
433 participant-experimenter interaction by increasing interaction during the control condition. For
434 example, participants in both conditions could be reminded that they can change the exercise
435 intensity at any time, but pleasure would only be emphasized in one of the conditions. Relatedly,
436 we cannot rule out experimenter demand effects, which created a potential limitation of the
437 study: no deception was used, so participants were likely aware that the Prompt condition was
438 designed to create more pleasure, and they may have adjusted their ratings of the exercise session
439 based on this expectation. Finally, participants may not have understood that they could change
440 the intensity multiple times throughout the exercise session as this was not specifically
441 emphasized in the instructions. This should have been emphasized along with the existing
442 statements that the intensity selected was the choice of the participants.

443 **Conclusions and Future Directions**

444 This study highlights that it is possible to alter the affective experience of exercise
445 without changing the intensity of the exercise session (as measured by HR and RPE); both
446 conditions elicited an exercise intensity that is within the recommended range for health
447 promotion by the American College of Sports Medicine (Garber et al., 2011). In this experiment,
448 pleasure and enjoyment of an exercise session were not solely contingent on physical exertion
449 (as measured by HR and RPE). Thus, psychological mechanisms (such as autonomy, control,
450 and reappraisal of affective states), in conjunction with physiological variables, should be
451 emphasized in research examining exercise enjoyment and potential impacts on future exercise
452 behavior.

453 Second, future research should examine the role of prompts to increase pleasure and
454 enjoyment over longer-duration exercise sessions. It is possible that a longer exercise session
455 would have produced stronger effects – in this experiment, differences in affective valence
456 between conditions emerged in the second half of the exercise session, compared to the first. In a
457 longer exercise session, researchers should consider the ideal frequency of reminders (to avoid
458 measurement fatigue and potential annoyance from frequent interruptions). Additional research
459 is needed to test how longer bouts of exercise might impact affective responses and to determine
460 the ideal frequency of during-exercise pleasure prompts.

461 Additionally, the experiment illustrates that using simple verbal prompts enhances
462 participants' experience of exercise, which easily lends these findings to naturalistic field
463 settings. Thus, future researchers could apply and test these interventions by creating orientation
464 sessions designed to teach participants how to maximize their own pleasure. Focusing on
465 breathing, heart rate, and RPE are common methods utilized, but training people to focus their
466 attention on maximizing pleasure and enjoyment in the exercise context is less common and may
467 also be beneficial, based on results from this experiment.

468 Finally, this experiment has important implications for the impact of pleasure on exercise
469 behavior. Pleasure experienced during exercise predicts future exercise behavior (Rhodes &
470 Kates, 2015). The prompts in this experiment also enhanced enjoyment, remembered pleasure,
471 and postexercise pleasure. It is possible that prompts that experimentally increase pleasure might
472 also influence future exercise intentions or exercise behavior itself. Thus, extensions of this work
473 should measure the effect of momentary pleasure reminders and transient increases in pleasure
474 on long-term exercise behavior.

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620 Table 1: Means and Standard Deviations for Affective Valence, Remembered Enjoyment, Remembered
 621 Pleasure, Heart Rate, and Perceived Exertion

	Prompt Condition		Control Condition	
	M	SD	M	SD
Affective Valence				
Pre-exercise	2.51	1.72	2.59	1.79
Minute 2	2.41	1.53	2.36	1.51
Minute 4	2.46	1.52	2.21	1.36
Minute 6	2.95	1.23	2.26	1.50
Minute 8	2.77	1.60	2.13	1.72
Minute 10	2.77	1.60	2.13	1.51
Post-exercise	3.38	1.31	2.79	1.47
Remembered Enjoyment	5.19	0.83	4.95	0.86
Remembered Pleasure	78.50	15.10	67.25	20.51
Heart Rate				
Pre-exercise	47.66	7.70	48.47	7.03
Minute 2	63.23	8.16	64.04	10.01
Minute 4	65.83	9.53	67.48	10.66
Minute 6	67.00	10.84	69.08	12.24
Minute 8	68.49	12.03	70.28	13.16
Minute 10	69.51	12.92	69.97	13.67
Perceived Exertion				
Minute 2	11.33	1.63	11.26	1.67
Minute 4	11.85	1.83	12.10	1.54
Minute 6	11.60	2.17	12.41	1.86
Minute 8	12.08	2.23	12.90	1.90
Minute 10	12.23	2.49	12.51	2.01

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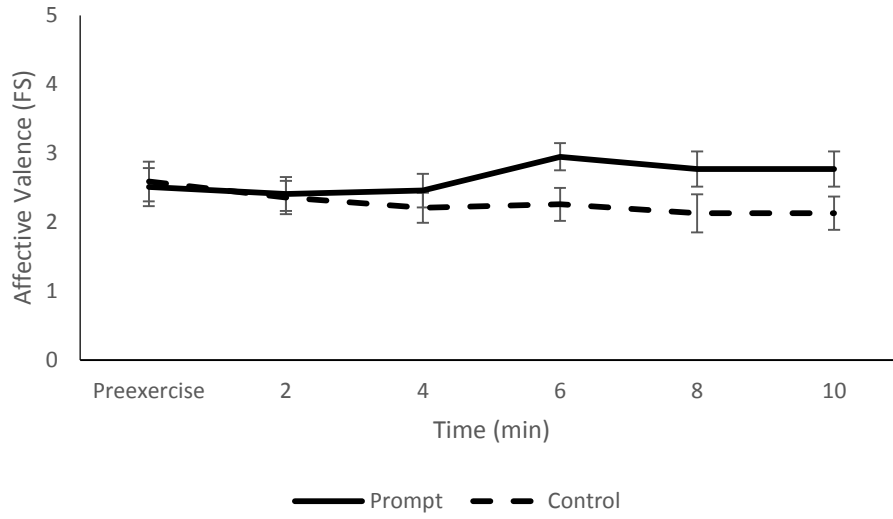
639 *Note.* M = Mean. SD = Standard Deviation. Affective valence ranges from -5 (Very Bad) to +5
 640 (Very Good). Remembered enjoyment ranges from 1 to 7. Remembered pleasure ranges from 0
 641 (It was a very negative experience) to 100 (It was a very positive experience). Heart rate is
 642 presented as a percentage of age-predicted maximum. Rating of Perceived Exertion ranges from
 643 6 to 20.

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649 Figure 1. Affective valence over time during each condition. Standard error bars are shown for
650 each time point.

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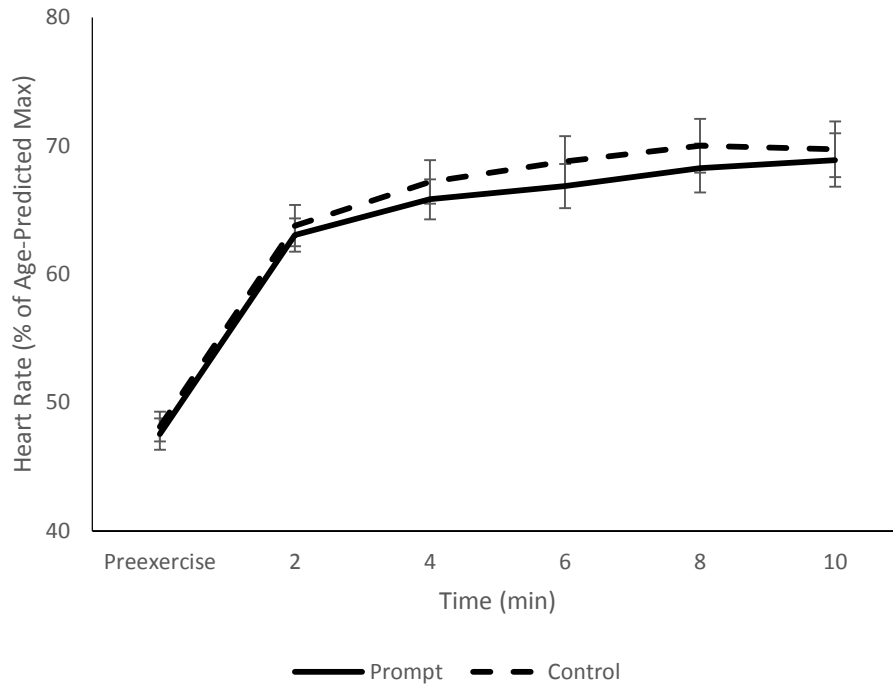
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662 Figure 2. Heart rate over time during each condition. Standard error bars are shown for each time
 663 point.

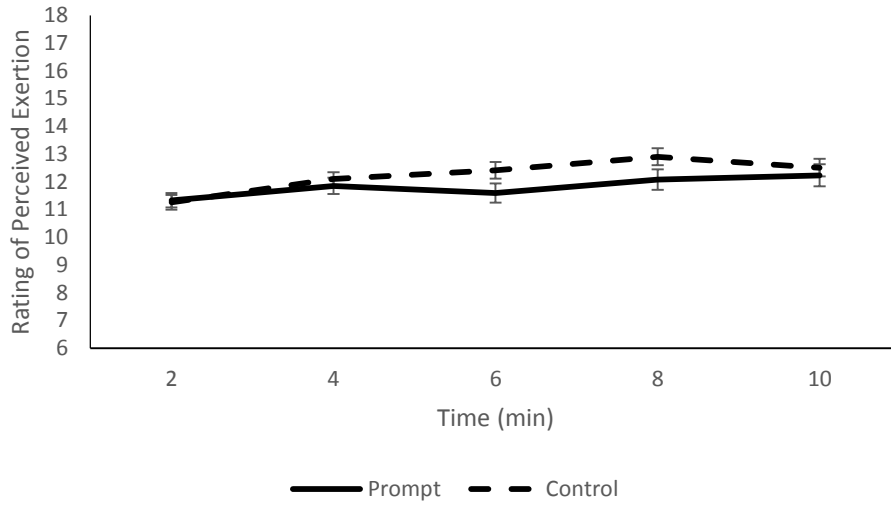
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670 Figure 3. Ratings of Perceived Exertion over time during each condition. Standard error bars are
671 shown for each time point.

672