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- 24 Relations between Autonomous Motivation and Leisure-Time Physical Activity
- 25 Participation: The Mediating Role of Self-Regulation Techniques
- 26
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28 **Abstract**

29

30 This study tested the predictive validity of a multi-theory process model in which the effect
31 of autonomous motivation, from self-determination theory, on physical activity participation
32 is mediated by the adoption of self-regulatory techniques based on control theory. ██████████
33 adolescents (N=411, aged 17-19) completed a prospective survey including validated
34 measures of the predictors and physical activity, at baseline and after one month (N=177). A
35 subsample used an accelerometer to objectively measure physical activity and further validate
36 the physical activity self-report assessment tool (*n*=44). Autonomous motivation statistically
37 significantly predicted action planning, coping planning and self-monitoring. Coping
38 planning and self-monitoring mediated the effect of autonomous motivation on physical
39 activity, although self-monitoring was the most prominent. Controlled motivation had no
40 effect on self-regulation techniques or physical activity. Developing interventions that
41 support autonomous motivation for physical activity may foster increased engagement in
42 self-regulation techniques and positively affect physical activity behavior.

43

44 **Keywords:** intrinsic regulation, action planning, coping planning, self-monitoring, self-
45 regulation strategies.

46

47 **Introduction**

48 Young people engage in insufficient physical activity for good health (Hallal et al.,
49 2012). In addition, levels of physical activity have often been found to decline from
50 childhood to adolescence and during adolescence (Dumith, Gigante, Domingues, & Kohl,
51 2011). Children and adolescents are a key group in which to promote an active lifestyle as
52 they need physical activity for healthy development (Biddle, Gorely, & Stensel, 2004).
53 Furthermore, promotion of physical activity in young people is also important for lifelong
54 physical activity given that physical activity levels in adolescence are moderately associated
55 with physical activity in adulthood (Hallal, Victora, Azevedo, & Wells, 2006).

56 A considerable body of research has sought to identify the psychological constructs
57 associated with health behaviors like physical activity (e.g. Bélanger-Gravel, Godin, &
58 Amireault, 2013; Chatzisarantis, Hagger, Biddle, Smith, & Wang, 2003; Michie, Abraham,
59 Whittington, McAteer, & Gupta, 2009; Ng et al., 2012; [Webb & Sheeran, 2006](#)). In
60 particular, researchers are interested in identifying the psychological constructs correlated
61 with health behavior that can be changed or manipulated using persuasive communications
62 and behavior-change techniques that target these psychological correlates (Hagger, 2010;
63 Michie, 2008; [Michie & West, 2013](#)). Based on the assumption that manipulable
64 psychological constructs are closely related to behavior, evoking a change in such construct
65 will lead to a concomitant, meaningful change in health behavior. Motivation and intentions
66 are constructs that have been shown to significantly predict multiple health behaviors, in the
67 context of a number of social psychological theoretical paradigms (Chatzisarantis et al., 2003;
68 Rich, Brandes, Mullan, & Hagger, 2015). Prominent among these paradigms is self-
69 determination theory (Deci & Ryan, 2000), which has received considerable attention in the
70 literature as an effective means to explain variance in health-related behavior and as a basis
71 for intervention.

72 It is the focus on the quality of motivation, rather than quantity alone, that sets self-
73 determination theory (Deci & Ryan, 2000) apart from other theories and models. The critical
74 distinction in the theory is the difference between autonomous and controlled forms of
75 motivation. Autonomous motivation is characterized by a sense of choice, volition, and
76 freedom from external pressure. Individuals who are autonomously motivated tend to act for
77 personally-endorsed reasons. Controlled motivation is used to describe acting for external
78 rewards, demands, or coercion. Individuals who are control motivated tend to act for other- or
79 externally-referenced reasons. Within these global categories of motivation, the theory
80 conceptualizes four different types of regulation that vary in their degree of autonomy.
81 *Intrinsic motivation* is the prototypical form of autonomous motivation and reflects engaging
82 in a behavior in the absence of external contingency and for the inherent pleasure and
83 satisfaction derived from the activity. *Identified regulation* is another form of autonomous
84 regulation and reflects acting to obtain self-endorsed goals or outcomes. The goals or
85 outcomes are not strictly intrinsic because they are separable from the behavior itself, but
86 individuals accept the external goals because the outcomes are appreciated or personally
87 valued. *External regulation* is the prototypical form of controlled motivation and reflects
88 acting for externally-referenced reasons such as to avoid punishment or to obtain a reward.
89 The contingency is therefore entirely outside the individual and therefore referenced by
90 others, not the self. *Introjected regulation* is a controlled form of motivational regulation in
91 which external control is partially assimilated, so the behavior is felt as a necessity or a
92 compulsion and may be performed in order to avoid guilt and shame (Deci & Ryan, 2000).

93 Autonomous forms of motivation have been shown to be significantly related to
94 health behavior engagement while controlled forms are related to desistence and avoidance
95 (Chatzisarantis et al., 2003; Ng et al., 2012; Teixeira, Carraça, Markland, Silva, & Ryan,
96 2012). This is because autonomous reasons for acting do not depend on external

97 contingencies or cues and are self-regulated rather than other-regulated. Motivation is,
98 therefore, perpetuated by the self and not dependent on prompts or nudges elsewhere.
99 Identified regulation has been associated more strongly to initial or short-term adoption of
100 exercising than any other regulation style (Hagger & Chatzisarantis, 2012; Hagger,
101 Chatzisarantis, & Biddle, 2002), whereas intrinsic motivation has been found to be the
102 strongest predictor of persistent exercise (Deci & Ryan, 2000; [Teixeira et al., 2012](#)).

103 It is important to note that motivation alone does not always lead to engagement in
104 health behavior (Hagger & Chatzisarantis, 2014; [Orbell & Sheeran, 1998](#); Webb & Sheeran,
105 2006), and the importance of self-regulation mechanisms for turning the motivation into
106 action has also been underlined (Hagger, Wood, Stiff, & Chatzisarantis, 2010; Sniehotta,
107 Schwarzer, Scholz, & Schüz, 2005). Many models and theories in health behavior have
108 identified behavioral enactment as at least a dual-phase process, with separate motivational
109 and implemental phases ([Heckhausen & Gollwitzer, 1987](#); [Schwarzer, 2008](#)). In the
110 motivational phase individuals form motives or intentions to engage in a course of action. In
111 the implemental phase individuals engage in volitional processes such as planning to enact
112 the intentions. For instance, action planning which consists of detailed where, when, how,
113 and how often plans, has been found to predict behavioral execution (Bélanger-Gravel et al.,
114 2013; [Hagger & Luszczynska, 2013](#)). Coping planning, identifying ways of overcoming
115 specific, foreseeable barriers to maintenance and preventing relapses, is an effective
116 technique for behavior change especially when combined with action planning (Kwasnicka,
117 Penseu, White, & Sniehotta, 2013). A systematic review also has shown the effectiveness of
118 coping planning in increasing physical activity (Carraro & Gaudreau, 2013). Another
119 volitional technique that has been shown to be important in improving behavioral
120 engagement is self-monitoring, that is, keeping a record of specific behaviors (Abraham &
121 Michie, 2008). Self-monitoring has been found to be especially effective for diet and physical

122 activity change, particularly when combined with other self-regulation techniques (Michie et
123 al., 2009). This might be due to the mechanism specified by the control theory (Carver &
124 Scheier, 1982) in which observation of a discrepancy between behavioral goals and actual
125 behavior leads to new action plans and new monitoring until the goal has been achieved.

126 Considering the importance of both motivational and implemental phases,
127 surprisingly few researchers have investigated the interplay of motivational determinants of
128 action, such as self-determined motivation, and use of self-regulation techniques in predicting
129 physical activity. There is precedent for examining motivational factors alongside
130 implemental factors, and these have found important interactions between the two (e.g.
131 [Hagger et al., 2012](#); Milne, Orbell, & Sheeran, 2002; Prestwich, Lawton, & Conner, 2003).
132 However, few studies have examined this in the context of autonomous forms of motivation
133 from self-determination theory. The limited data in this context has demonstrated that action
134 planning partially mediates the relationship between autonomous motivation and physical
135 activity (Li, Iannotti, Haynie, Perlus, & Simons-Morton, 2014) and the translation of
136 intention into behavior change via planning was facilitated by autonomous motivation (Cao,
137 Lippke, & Liu, 2011). However, no study so far has investigated both planning and self-
138 monitoring behaviors in combination with motivational quality.

139 **The Present Study**

140 The primary purpose of the present research is to investigate whether individuals who
141 are autonomously motivated to engage in leisure-time physical activity behavior are more
142 likely to adopt self-regulatory techniques that will be instrumental in them engaging in the
143 behavior. According to this hypothesis, autonomous motivation facilitates an individual to
144 strategically ‘mobilize’ their self-regulatory resources to bring about the desired autonomous
145 behavior in future. In addition, we also aim to examine the processes behind relations
146 between autonomous motivation and physical activity participation. This is based on the

147 premise that autonomous motivation is converted into action due to the adoption of self-
148 regulatory techniques. In other words, individuals that are autonomously motivated are more
149 likely to persist with behaviors due to their inherent value. But in order to do so, they have to
150 strategically engage in volitional techniques that will assist them in successfully structuring
151 their environment to ensure successful behavioral engagement (e.g., action and coping
152 planning) and behavioral regulation (e.g., self-monitoring). We would therefore expect that
153 the adoption of the techniques explains (i.e., mediates) the effect of autonomous forms of
154 motivation on physical activity behavior.

155 **Methods**

156 **Sample and Procedure.** Participants were students from eight upper secondary
157 schools: six vocational schools from the largest municipal education and training consortia ■
158 ■, and two geographically matching high schools. The vocational schools represent
159 diverse study fields such as tourism industry, beauty care, catering, metalwork and
160 machinery, while high schools have an academic-focused curriculum. We excluded
161 participants older than 19 years, after which the final recruited sample comprised 411
162 adolescents (57% girls) with the age range of 17-19 ($M = 17.8$ years, $SD = 0.69$). Participants
163 completed an initial online questionnaire (Time 1; T1) containing self-reports of
164 demographic, psychological (motivational regulations, action and coping planning), and
165 behavioral (physical activity participation) variables during March and April 2013. Forty-
166 three percent of the adolescents ($N = 177$; 63% girls, M age = 17.7, $SD = 0.70$; Attrition rate
167 = 43.07%) completed a follow-up online questionnaire containing self-report measures of
168 self-monitoring and physical activity behavior 3 to 5 weeks later (Time 2; T2). Participants
169 completed survey measures in quiet conditions under teacher supervision. The respondent
170 drop-out rate was mainly due to students' practical training periods outside of the vocational
171 schools and teachers' time pressure. Participation in the study was voluntary and all

172 participants gave informed consent prior to data collection. The questionnaire and the study
173 protocol were reviewed by the research ethics committee of [REDACTED]
174 [REDACTED].

175 **Measures**

176 **Motivational Regulations from Self-Determination Theory.** The Self-Regulation
177 Questionnaire (Ryan & Connell, 1989) adapted for exercise was used to measure
178 motivational regulations at T1. Participants were presented with an initial item ‘stem’: “There
179 are a variety of reasons why people exercise regularly. Please indicate how true each of these
180 reasons is for why you exercise regularly. I try to exercise on a regular basis...”, was
181 followed by 16 items four for each of the self-determination theory motivational regulations:
182 internal regulation (e.g., “...because I enjoy exercising”), identified regulation (e.g.,
183 “...because feeling healthier is an important value for me”); introjected regulation (e.g.,
184 “...because I feel guilty if I do not exercise regularly”), and external regulation (e.g.,
185 “...because others make me do it. In the present study, items from the intrinsic and identified
186 regulation scales were proposed to indicate an autonomous motivation factor, and items from
187 the introjected and external regulation scales were proposed to indicate a controlled
188 motivation factor. The items were averaged summed variables for the purposes of descriptive
189 statistics and drop-out analyses, and as latent variables in the structural equation model.
190 Higher levels on each sub-scale indicate higher levels of that kind of regulation.

191 **Planning.** Action planning for leisure-time physical activity was measured at T1
192 using four items ([Sniehotta et al., 2005](#)) (e.g. “I have made a detailed plan regarding when to
193 exercise over the next two weeks”). Coping planning was measured using four items
194 following the common stem “I have made a detailed plan regarding...” (e.g., “...what to do if
195 something interferes with my plans for regular physical activity”) with responses given on a

196 scale ranging from 1 to 4 (Sniehotta et al., 2005), with higher numbers indicating more
197 coping plans.

198 **Self-monitoring.** Two items assessed self-monitoring at T2 (e.g., “During the last
199 four weeks, I have constantly monitored myself whether I exercise frequently enough”) with
200 responses given on a scale ranging from 1 (definitely false) to 7 (definitely true) (Sniehotta et
201 al., 2005).

202 **Leisure-time Physical Activity.** Self-reported physical activity during leisure time
203 was assessed at T1 and T2 using a single item from the validated Nord-PAQ measure
204 (Rasmussen et al., 2012): “During the last seven days, on how many days were you
205 physically active so that the activity intensity was moderate or vigorous and you were active
206 at least 30 minutes per one day”. Responses were provided on an eight-point scale ranging
207 from 0 to 7 days. To ensure concurrent validity of the self-report measure we measured
208 physical activity objectively using a 3-axis accelerometer (Hookie Meter v2.0, Hookie
209 Technologies Ltd, Espoo, Finland) in a sub-sample ($n = 44$) of adolescents (Vähä-Ypyä et al.,
210 2015). Activity data were registered as raw data at a 100 Hz sample rate on a 2GB internal
211 flash memory. Accelerometers were worn for seven consecutive days. The correlation
212 coefficient between the accelerometer-measured average daily physical activity
213 (approximately above four METs, representing moderate to vigorous physical activity) and
214 self-reported physical activity (above) was statistically significant ($r = .38, p < .02$).

215 **Data Analysis**

216 Prior to analysis, missing values were imputed using the multiple imputation features
217 of the IBM SPSS version 23 software, values were imputed for psychological data only and
218 where less than 5% of values were missing, Behavioral data was not imputed. Drop-out
219 analyses were conducted with MANOVA, chi-square tests, and *t*-tests using SPSS. A
220 structural equation model using a maximum likelihood method was conducted with the

221 Mplus version 7.31 statistical software (Muthén & Muthén, 2015). All the psychological
222 variables in the model were represented as latent variables indicated by multiple items from
223 their questionnaire measures. Gender, age, and past physical activity behavior at T1 were
224 included as control variables which predicted all other variables in the model. Age, physical
225 activity behavior at T2, and past physical activity behavior, were included as continuous non-
226 latent variables and gender was included as a dichotomous non-latent variable coded as 1 =
227 boys, 2 = girls. The hypothesized relations among the variables in the proposed model are
228 summarized in Figure 1. At the measurement level, construct validity of the latent factors was
229 established using the average variance extracted (AVE) and composite reliability coefficients
230 (ρ) which should exceed .50 and .70, respectively (Diamantopoulos & Siguaw, 2000).
231 Adequacy of the hypothesized model was established using the comparative fit index (CFI)
232 and the Tucker-Lewis Index (TLI) index, with values exceeding .90 typically considered
233 appropriate cutoff values for adequate model fit, and the root mean squared error of
234 approximation (RMSEA) and its 90% confidence intervals (CI_{90}), with a cutoff value equal to
235 or less than .08 and narrow confidence intervals indicative of an adequately-fitting model
236 (Marsh, Hau, & Wen, 2004). Hypothesized mediation effects were tested by calculating
237 indirect effects with bootstrapped standard errors.

238 Results

239 Preliminary Analyses

240 The descriptive statistics are displayed in Table 1. A MANOVA with physical activity
241 and the study psychological variables as multiple dependent variables and study drop-out as
242 the independent variable revealed an overall statistically non-significant multivariate effect,
243 Pillai's Trace = 0.23, $F(5, 390) = 1.87$, $p = .099$. The analysis indicated that participants that
244 did not participate at T2 did not differ on psychological variables or physical activity
245 compared to those that remained in the study. Those that dropped out from the study were

246 older than those who remained in the study ($t(409) = -2.57, p = .011$) which may be due to a
247 higher number of older students doing practical training outside of school. Differences in
248 gender distribution between the final sample and drop-outs between T1 and T2 did not reach
249 statistical significance ($\chi^2(1) = 3.83, p = .055$). Zero-order intercorrelations, average variance
250 extracted (AVE) and reliability coefficients for study variables are presented in Table 2. We
251 also checked intraclass correlation coefficients (ICC) for study variable scores across schools
252 to check for clustering of data and ensure that scores were not dependent on school
253 membership. The ICC values were not statistically significant for any of the variables (ICC
254 range = .005 to .048) indicating that clustering is negligible.

255 **Structural Equation Model**

256 Prior to evaluating study hypotheses in the structural equation model, we examined the
257 solution estimates to ensure that the psychological constructs were sufficiently well defined.
258 Examination of the factor loadings indicated large factor loadings for the action planning,
259 coping planning, and self-monitoring factors. Furthermore, items from the intrinsic and
260 identified regulation scales of the Self-Regulation Questionnaire loaded on a single
261 autonomous motivation factor as did items from the introjected and external regulation scales
262 to form a controlled motivation factor with AVE values approaching or exceeding the .50
263 cutoff considered appropriate for adequate construct validity. This justifies our approach to
264 reducing the number of variables in our model consistent with previous research (e.g., Chan
265 & Hagger, 2012; Hagger et al., 2002).

266 Standardized parameter estimates for the structural relations among the proposed model
267 are given in Figure 2. Overall, the model indicated adequate model fit, CFI = .916, TLI =
268 .902, RMSEA = .062 (CI₉₀ upper limit = .072; CI₉₀ lower limit = .055). In addition, the model
269 accounted for a statistically significant amount of variance in the key dependent variables
270 measured at T2: self-monitoring ($R^2 = .37$) and leisure time physical activity ($R^2 = .36$).

271 There were statistically significant direct effects of autonomous motivation on action
272 planning ($\beta = .53, p < .001$) and coping planning ($\beta = .51, p < .001$), and self-monitoring on
273 physical activity ($\beta = .28, p = .004$). There was also a statistically significant direct effect of
274 autonomous motivation on self-monitoring ($\beta = .27, p = .005$). In terms of indirect effects, we
275 found statistically significant overall indirect effect of autonomous motivation on physical
276 activity through the mediated paths in the model ($\beta = .14, p = .042$), although the most
277 substantive indirect effect was directed through self-monitoring ($\beta = .08, p = .050$). There
278 was therefore a statistically significant total effect of autonomous motivation on physical
279 activity comprising the direct and indirect effects ($\beta = .22, p < .001$). We also found a
280 statistically significant indirect effect of autonomous motivation on self-monitoring through
281 coping planning ($\beta = .12, p = .021$) and a statistically significant total effect comprising the
282 direct and indirect effects ($\beta = .39, p < .001$).

283 Discussion

284 The purpose of the present study was to examine interrelationships between quality of
285 motivation, self-regulatory techniques, and physical activity behavior, and explore the
286 possible mediating role of self-regulatory techniques in the relationship between autonomous
287 motivation and physical activity behavior. Results indicated that young people who were
288 autonomously motivated (i.e., derive enjoyment from exercising or feel that physical activity
289 goals are personally important to them) were more likely to engage in strategic efforts to
290 pursue those behaviors such as planning and monitoring their progress compared with those
291 who exercise for controlled reasons (i.e, to avoid guilt, shame, or judgment). This further
292 sheds light on mechanisms by which autonomous motivation may exert its effect on
293 behaviors.

294 Importantly, the relationship of autonomous motivation and physical activity was
295 found to be partially mediated by self-regulation techniques, particularly self-monitoring.

296 This underlines that the reason why autonomous aspirations for exercise translate into
297 physical activity is because individuals are more likely to adopt self-regulatory techniques.
298 Thus, interventions may benefit from fostering autonomous motivation by, for instance,
299 addressing adolescents' using autonomy-supportive rather than controlling language, offering
300 them choices, options and a meaningful rationale for the activities, supporting their
301 confidence in their abilities, accepting and recognizing their efforts, and supporting positive
302 interaction and relatedness with their peers ([Hagger et al., 2007](#)). In fact, the climate of trust
303 and personal agency generated by autonomy support may lead adolescents to adopt
304 appropriate and adaptive self-regulation techniques such as coping and planning and self-
305 monitoring. A recent systematic review (Hynynen et al., in press) showed that school-based
306 physical activity interventions for adolescents often include self-regulation techniques, but so
307 far, randomized controlled trials have failed to demonstrate maintenance of behavior change.
308 The current study implies that components enhancing autonomous motivation may be a
309 critical element to add to such interventions in order to enhance long-term effectiveness.

310 The current study implies that components enhancing autonomous motivation may be
311 a critical element to add to such interventions in order to enhance long-term effectiveness.
312 We speculate that the link between autonomous motivation and self-regulatory activities in
313 the current research occurs due to a strategic aligning of self-regulatory techniques to
314 maximize participation in the activity among autonomously-motivated young people.
315 Prominent among these techniques is self-monitoring, that is, engaging proactively in
316 keeping track of their actions relating to their goals. Self-monitoring may act as a means for
317 tracking personal improvement and achievement of challenging goals and this may be a
318 reason for the link between autonomous motivation and self-monitoring. Another such
319 technique is planning, a volitional technique that helps making time for, and initiating, a
320 desired activity (Schwarzer, 2015) – even highly enjoyable activities can be overlooked due

321 to everyday stress and hurry. Planning is therefore consistent with individuals' motives to
322 serve their autonomous goals.

323 We also tested for the effects of gender on the study variables. We found that boys
324 reported higher levels of physical activity participation, higher extrinsic regulation, and
325 higher levels coping planning. Differences in coping planning might contribute to the gender
326 difference in physical activity observed in other studies (e.g. Dumith et al., 2011). It has been
327 argued that in early adolescence, coping planning would be an especially important self-
328 regulation technique, because young people may be motivated to shield their intentions to
329 engage in counter-normative behaviors against peer pressure, and their self-regulatory
330 capacities to follow a plan may be limited (Araújo-Soares, McIntyre, & Sniehotta, 2009). For
331 example, forming coping plans to deal with potential stigma associated with non-normative
332 behaviors, such as doing physical activity in front of others when others are engaging in more
333 sedentary pastimes, may be an important determinant of the physical activity of young
334 people. It is also possible that other factors indicated by the gender differences, such as
335 gender roles, affect both coping planning and physical activity. Including specific gender
336 roles or gender-role related traits (e.g. [Hankonen, Kontinen, & Absetz, 2014](#)) with respect to
337 physical activity as predictors in theoretical models may further elucidate these influences.

338 Future studies could examine whether the association of autonomous-motivation with
339 planning and self-monitoring can be explained by the nature of self-regulation: skillful use of
340 self-regulation techniques may help individuals to follow their values, succeed in their
341 efforts, and thrive in relationships. Self-directed planning and monitoring of progress can be
342 experienced as autonomy supportive, especially if the plans are achievable, personally
343 relevant, and enjoyable, and lead to continuous accomplishments, verified by self-monitoring.
344 Fostering self-monitoring and planning for physical activity in an autonomy supportive
345 manner would have the potential to reinforce both motivation and behavior.

346 In addition to measuring use of self-regulatory techniques, future studies could
347 measure also other change strategies that individuals enact to obtain their desired behavior
348 change, such as using prompts to maintain motivation and remind individuals of their plans
349 (Hankonen et al., 2015). This would be especially useful in behavior change interventions
350 where investigating the actual uptake of behavior change techniques represents an important,
351 yet understudied aspect of intervention fidelity (Bellg et al., 2004; Greaves, 2015).

352 **Strengths and Limitations**

353 The strengths of this study were the adoption of constructs from theoretical
354 frameworks that are frequently used to predict leisure-time physical activity (Chatzisarantis et
355 al., 2003; Hagger et al., 2002), using validated measures, and integrating them to test unique
356 hypotheses regarding motivated action. In addition, the study used comprehensive sampling
357 which covered different education levels and professional orientations, thus overcoming the
358 frequent criticism that research is biased due to the preponderance of university or high-
359 school student samples. Limitations of the study include the reliance on self-report measures
360 and the correlational design, which limits the inference of causality. It is important to note
361 that we attempted to address the issue of self-reported behavior by validating our self-
362 reported physical activity measure using an objective measure, an accelerometer, a strength
363 of the current study as this is seldom done in research of this kind. It must, however, be
364 stressed that this was conducted on a relatively small sub-sample. Furthermore, we controlled
365 for past physical activity behavior, an important endeavor in research adopting theoretical
366 models as it accounts for habits and previous decision making. Specifically, the inclusion of
367 past behavior may serve as a proxy for effects of baseline measures of psychological
368 variables as it may reflect unmeasured behaviorally-relevant aspects of previous decision
369 making (Sutton, 1994). Future research may seek to address these limitations by controlling
370 for temporal changes using baseline measures or adopting cross-lagged panel (e.g., Lindwall,

371 [Larsman, & Hagger, 2011](#)) and experimental (e.g., [Hagger et al., 2012](#)) designs, which may
372 enable better inference of causality. Panel designs may also permit exploration of reciprocal
373 relations among the constructs in the proposed model. Experimental research may shed light
374 on whether particular behavior change interventions or strategies that target autonomous
375 motivation such as autonomy support may also result in the adoption of self-regulatory
376 techniques, as proposed in the current model (Chatzisarantis & Hagger, 2009; Mullan, Todd,
377 Chatzisarantis, & Hagger, 2014). Factorial designs may also allow for the adoption of other
378 techniques that target the self-regulation strategies independent of autonomy support and
379 examine whether these have differential, unique effects on the variables in the current model.

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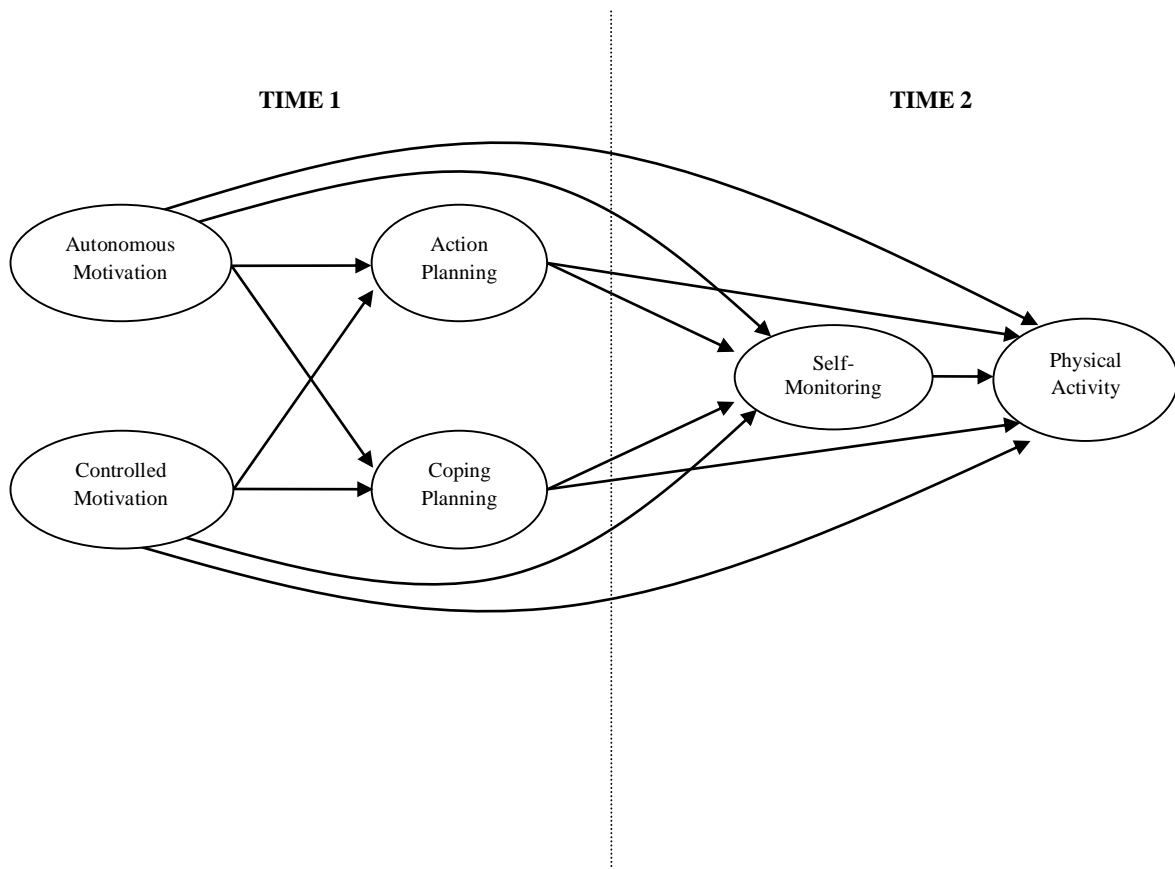


Figure 1. Proposed structural equation model illustrating effects among self-determination theory, planning, self-monitoring, and behavioral variable. Effects of gender, school, and past physical activity behavior as control variables on each variable in the model omitted for clarity.

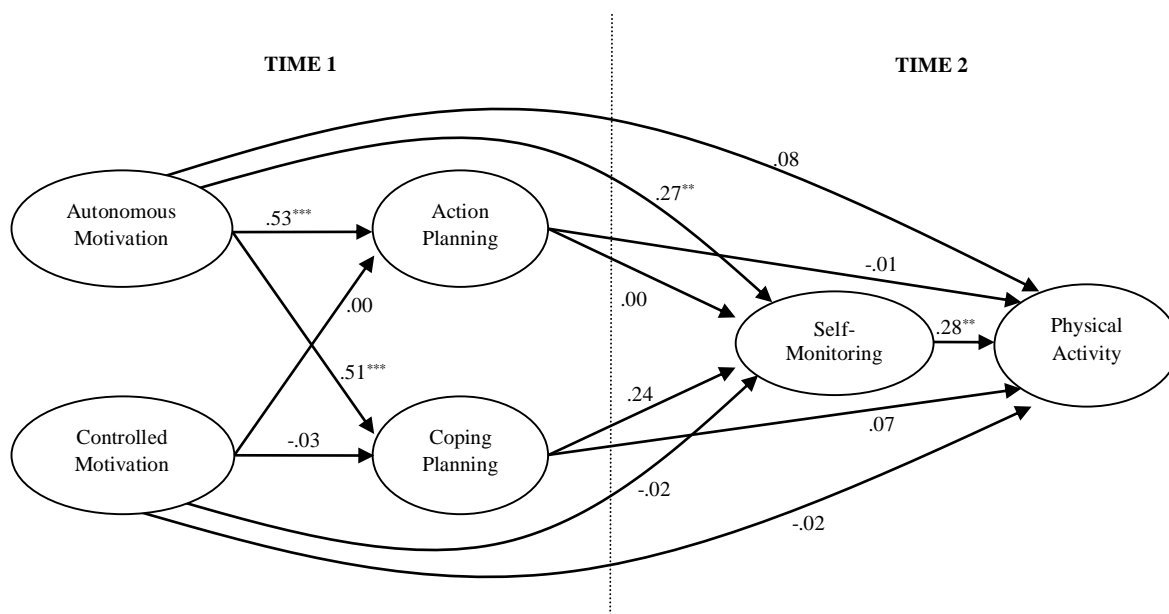


Figure 2. Standardized parameter estimates of a structural equation model of effects among motivation, planning, self-monitoring, leisure-time physical activity, and demographic variables. Statistically significant indirect effects not shown in model: Autonomous motivation → Physical activity ($\beta = .08, p = .050$); Autonomous motivation → Self-monitoring ($\beta = .12, p = .021$). Effects of gender, school, and past physical activity behavior as control variables on each variable in the model omitted for clarity, paths freely estimated in the model but not depicted in diagram: Gender → Autonomous motivation ($\beta = .05, p = .458$); Gender → Controlled motivation ($\beta = -.19, p = .026$); Gender → Action planning ($\beta = -.13, p = .025$); Gender → Coping planning ($\beta = -.24, p < .001$); Gender → Self-monitoring ($\beta = .04, p = .490$); Gender → Physical activity ($\beta = -.14, p = .054$); School → Autonomous motivation ($\beta = -.02, p = .771$); School → Controlled motivation ($\beta = .023, p = .78$); School → Action planning ($\beta = -.09, p = .097$); School → Coping planning ($\beta = -.10, p = .097$); School → Self-monitoring ($\beta = .13, p = .032$); School → Physical activity ($\beta = -.02, p = .757$); Past physical activity behavior → Autonomous motivation ($\beta = .46, p < .001$); Past physical activity behavior → Controlled motivation ($\beta = -.10, p = .307$); Past physical activity behavior → Action planning ($\beta = .21, p = .002$); Past physical activity behavior → Coping planning ($\beta = .22, p = .004$); Past physical activity behavior → Self-monitoring ($\beta = .20, p = .007$); Past physical activity behavior → Physical activity ($\beta = .31, p < .001$).

* $p < .05$ ** $p < .01$ *** $p < .001$

Table 1

Minimum and Maximum Values, Means, and Standard Deviations of Motivational Regulation Styles, Self-Regulation Techniques and Leisure Time Physical Activity

	Range ^a	Total M (SD)	Boys Mean (SD)	Girls Mean (SD)	<i>p</i> ^b
Intrinsic regulation	1-5	3.84 (0.97)	3.86 (0.96)	3.83 (0.98)	.835
Identified regulation	1-5	3.85 (0.96)	3.75 (0.96)	3.91 (0.96)	.272
Introjected regulation	1-5	2.78 (1.09)	2.71 (1.12)	2.83 (1.07)	.490
External regulation	1-5	1.78 (0.85)	1.98 (0.96)	1.65 (0.73)	.011
Autonomous motivation	1-5	3.85 (0.93)	3.80 (0.93)	3.87 (0.93)	.638
Controlled motivation	1-5	2.28 (0.84)	2.34 (0.93)	2.24 (0.78)	.424
Action planning	1-4	2.79 (1.02)	2.93 (0.94)	2.70 (1.06)	.146
Coping planning	1-4	2.52 (0.93)	2.79 (0.82)	2.38 (0.96)	.005
Self-monitoring (Time 2)	1-7	4.35 (1.60) ^b	4.29 (1.62)	4.38 (1.60)	.728
Physical activity (Time 2)	0-7	4.11 (1.77) ^b	4.50 (2.00)	3.90 (1.58)	.030
Past behavior (Physical activity)	0-7	3.94 (1.68)	3.98 (1.63)	3.95 (1.71)	.883

Note. ^aHigher scores indicate stronger agreement with the items; ^bStatistical significance from *t*-test for gender differences. All variables were measured at Time 1 unless otherwise indicated.

Table 2
Zero-Order Intercorrelations and Reliability Coefficients for Study Variables

Variable	AVE	1	2	3	4	5	6	7	8
1. Action planning	.87	(.96)							
2. Coping planning	.73	.83**	(.93)						
3. Autonomous motivation	.56	.62**	.59**	(.92)					
4. Controlled motivation	.29	.01	-.01	.00	(.84)				
5. Self-monitoring (Time 2)	.66	.45**	.48**	.52**	-.05	(.83)			
6. Physical activity (Time 2)	–	.37**	.40**	.38**	-.04	.48**	–		
7. Past behavior (Physical activity)	–	.44**	.45**	.46**	-.01	.45**	.49**	–	
8. Gender ^a	–	-.11	-.21**	.05	-.20	.01	-.15	-.01	–
9. School ^b	–	-.04	-.05	.04	.01	.15*	.06	.13	.02

Note. AVE = Average variance extracted of latent factors. Correlations with psychological constructs are latent factor correlations. Cronbach alpha reliability coefficients displayed on principal diagonal; ^aDichotomous variable coded as 1 = Boy, 2 = Girl; ^bDichotomous variable coded as 1 = vocational school, 2 = high school. All variables were measured at Time 1 unless otherwise indicated.

* $p < .05$ ** $p < .01$ *** $p < .001$