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**Author(s):** Barkoukis, Vassilis; Chatzisarantis, Nikos; Hagger, Martin S.

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**Effects of a School-based Intervention on Motivation for Out-of-school Physical Activity  
Participation**

**Vassilis Barkoukis<sup>1</sup>, Nikos L. D. Chatzisarantis<sup>2</sup>, & Martin Hagger<sup>3,4</sup>**

<sup>1</sup>Aristotle University of Thessaloniki

<sup>2</sup>Curtin University

<sup>3</sup>University of California, Merced

<sup>4</sup>University of Jyväskylä

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27 Evidence suggests that physical inactivity has deleterious effects on the physical and mental  
28 health in young people and contributes to increased risk of chronic disease. For example, low levels of  
29 physical activity has been associated with overweight and obesity and higher risk for cardiovascular  
30 disease in school-aged children (Carson et al., 2016; Kurdaningsih, Sudargo, & Lusmilasari, 2017).  
31 Furthermore, low levels of physical activity has been shown to be related to depressive symptoms,  
32 psychological distress, low self-esteem, hyperactivity and attention problems, anti-social behavior, and  
33 impaired psychological well-being and perceived quality of life (Carson et al., 2016; Hoare, Milton,  
34 Foster, & Allender, 2016; Suchert, Hanewinkel, & Isensee, 2015). In contrast, regular participation in  
35 physical activity in young people is associated with reduced risk of illness, and positive mental health  
36 outcomes (Biddle, Ciaccioni, Thomas, & Vergeer, 2019; Ekelund et al., 2009). These benefits  
37 notwithstanding, there is consistent evidence that children and adolescents in many nations do not  
38 participate in sufficient physical activity confer these health benefits and reduce disease risk.  
39 Governments and health departments have therefore produced guidelines and recommendations on  
40 the appropriate levels of physical activity for good health in young people, and developed strategy  
41 documents and interventions to promote physical activity (Breda et al., 2018).

42 Physical education (PE) stands as a useful existing network that can be utilized to deliver  
43 interventions aimed at fostering regular participation in physical activity in children and adolescents  
44 (Cooper et al., 2016). This has led researchers to explore potential strategies on how to promote  
45 increased physical activity in PE students, an endeavor that necessitates an understanding of how  
46 contextual factors in PE can foster students motivation toward physical activity. One perspective has  
47 been to study how the behaviors displayed by social agents (e.g., teachers, parents, peers) in social  
48 contexts can promote motivation and behavior toward activities in class. With respect to PE lessons, an  
49 autonomy-supportive environment has been shown to result in adaptive responses in students related  
50 to the lesson itself such as vitality, enjoyment, effort, and reduced anxiety (Liukkonen, Barkoukis, Watt,  
51 & Jaakkola, 2010; Mouratidis, Vansteenkiste, Sideridis, & Lens, 2011). However, less attention has

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52 been focused on the role of school PE in promoting students' out-of-school participation in physical  
53 activity, an important priority for PE teachers, health educators, and curriculum developers (Klein &  
54 Hardmann, 2007).

55         There is, however, growing evidence that an autonomy-supportive environment in PE may  
56 promote out-of-school physical activity (Hagger & Chatzisarantis, 2016; Hagger, Chatzisarantis,  
57 Culverhouse, & Biddle, 2003). Specifically, research has focused on identifying how promoting  
58 students' motivation toward activities in PE may also affect their motivation toward, and actual  
59 participation in, physical activity outside of school. The trans-contextual model (TCM; Hagger et al.,  
60 2003) was developed for this purpose, and aims to describe the process by which support for  
61 autonomous motivation in school influences students' participation in related activities outside school.  
62 The model integrates core constructs and processes from self-determination theory (Deci & Ryan,  
63 1985, 2002), the hierarchical model of intrinsic and extrinsic motivation (Vallerand, 1997, 2007;  
64 Vallerand & Ratelle, 2002), and theory of planned behavior (Ajzen, 1985, 1991, 2002). Self-  
65 determination theory (Deci & Ryan, 1985) specifies how the social environment (i.e., motivational  
66 climate) in educational settings relates to motivation and, importantly persistence on tasks (see Hagger,  
67 Hardcastle, Chater, Mallett, Pal, & Chatzisarantis, 2014). Vallerand's (1997, 2007) hierarchical model  
68 describes the process by which motivation is transferred between different contexts. The theory of  
69 planned behavior (Ajzen, 1985) outlines the decision making process by which individuals' beliefs and  
70 intentions with respect to particular behaviors lead to future behavioral participation. According to the  
71 model, an autonomy-supportive environment in school PE will foster students' autonomous motivation  
72 in PE which, in turn, will be transferred into autonomous motivation for out-of-school physical activity  
73 participation. Autonomous motivation for physical activity participation will influence actual behavior,  
74 through the belief-based constructs from the theory of planned behavior (i.e., attitudes, perceived  
75 behavioral control, subjective norms and intentions; Chan, Zhang, Lee, & Hagger, 2020; Hagger et al.,  
76 2003).

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77           The key premises of the model have received substantial empirical support in school PE and  
78 leisure-time physical activity (Barkoukis & Hagger, 2009, 2013; Hagger et al., 2003; González-Cutre et  
79 al., 2014a; González-Cutre, Sicilia, Beas-Jimenez, & Hagger, 2014b; Moreno-Murcia, Hernandez,  
80 Pedreno, & Neipp, 2017; Ntovolis, Barkoukis, Michelinakis, & Tsorbatzoudis, 2015; Shen, McCaughtry,  
81 & Martin, 2007, 2008). In addition, the cross-cultural invariance and replicability of the TCM in countries  
82 with notable cultural differences has been supported (Hagger et al., 2005; Hagger et al., 2009).  
83 Furthermore, evidence confirmed the utility of the model beyond PE; in science (Hagger & Hamilton,  
84 2018), mathematics (Hagger, Sultan, Hardcastle, & Chatzisarantis, 2015; Hagger et al., 2016), and for  
85 after school learning (Chan, et al., 2015). Research has also supported the predictions of the model  
86 beyond school PE, supporting the generalizability of its predictions (e.g., Chan et al., 2011, 2015;  
87 Hagger et al., 2016). A recent meta-analysis of studies applying the model in PE contexts also provides  
88 converging evidence supporting model predictions (Hagger & Chatzisarantis, 2016).

89           One of the key propositions of the TCM is that students' autonomous motivation will transfer  
90 across contexts and affect physical activity participation outside of school. It stands to reason, that  
91 fostering autonomous motivation in PE may be effective in promoting autonomous motivation toward,  
92 and actual participation in, physical activities in leisure time. PE may therefore serve as an opportune  
93 environment to administer interventions that target change in autonomous motivation that may have  
94 ramification beyond school. Research has demonstrated that social agents such as teachers can be  
95 effective in promoting greater autonomous motivation through the display of autonomy-supportive  
96 behaviors and autonomy-supportive interpersonal communications with students in lessons.

97           Prior research has consistently supported the positive effect of autonomy supportive  
98 environments on students' adaptive responses with respect to in- and out-of school cognition, affect,  
99 and behavior (Chatzisarantis, Hagger, & Brickell, 2008; Hagger & Chatzisarantis, 2016; Hastie, Rudisill  
100 and Wadsworth, 2013; Su & Reeve, 2011). Hence, in order to achieve positive outcomes from  
101 participation in PE lessons emphasis should be placed in the adoption of an autonomy supportive

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102 motivational climate. Such a climate adopts the students' perspective, allows students to express their  
103 thoughts and feelings, and promotes students' self-regulation (Reeve, 2009). In an autonomy-  
104 supportive motivational climate, teachers nurture students' inner motivational resources (e.g., interests,  
105 preferences, psychological needs), provide explanatory rationales (e.g., articulate the sometimes  
106 hidden usefulness underlying a teacher's request), rely on noncontrolling language (e.g., informational  
107 communications that help students diagnose and solve their motivational problems), display patience to  
108 allow students the time they need for self-paced learning to occur (e.g., allow time for students to work  
109 in their own way), acknowledge and accept students' expressions of negative affect (e.g., treat  
110 students' complaints as valid reactions to imposed demands and structures), and engender students'  
111 sense of choice over their behavior (Reeve, 2009, 2016; Reeve & Jang, 2006; Teixeira et al., 2020).  
112 Experimental studies in educational contexts have confirmed the positive effect of an autonomy  
113 supportive climate on students' responses (Su & Reeve, 2011). Furthermore, several intervention  
114 studies have demonstrated that programs that train teachers to be more autonomy supportive lead to  
115 greater use of autonomy-supportive strategies in the classroom (Cheon, Reeve, & Moon, 2012;  
116 McLachlan & Hagger, 2010), and adaptive educational outcomes in students including higher levels of  
117 autonomous motivation, need satisfaction, future intentions classroom engagement, and skill  
118 development (Cheon et al., 2012; Mandigo, Holt, Anderson, & Shepard, 2008; Murcia, Lacarcel, &  
119 Alvarez, 2010; Perlman, 2010; Tessier, Sarrazin, & Ntoumanis, 2010).

120         These studies provide initial evidence for the benefits of autonomy-supportive teaching  
121 environments in PE. Consistent with this research, the TCM has been suggested as a basis for PE-  
122 based interventions (Hagger & Chatzisarantis, 2016). However, to date, structured interventions using  
123 autonomy-supportive teaching strategies in high school PE to promote physical activity outside of  
124 school are scarce. Furthermore, with some notable exceptions (e.g., Cheon et al., 2012) all the above  
125 mentioned interventions measured outcomes solely in the school context, whereas there is a lack of  
126 evidence on the effects of a school-based interventions on motivation and behavior changes outside



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127 school. Furthermore, drawing from the TCM, there is relatively little evidence examining the processes  
128 by which school-based autonomy supportive interventions based on self-determination theory relate to  
129 physical activity participation outside of school. In particular, there is a dearth of studies examining  
130 theory-based motivational and social cognition mediators of the effects of such interventions on leisure-  
131 time physical activity in young people. The present study applied the TCM to address this evidence gap  
132 by investigating the effect of an autonomy-supportive school-based intervention on high school  
133 students' motivation and beliefs toward, and actual participation in, leisure-time physical activity.  
134 Specifically, the study aims to advance knowledge by demonstrating the processes by which an  
135 intervention promoting use of autonomy-supportive behaviors in PE teachers relates to out-of-school  
136 physical activity behavior in high school students. To date, research on the TCM has been largely  
137 confined to correlational, longitudinal and prospective studies, with virtually no data on whether model  
138 effects are supported when key constructs, namely perceived autonomy support, and autonomous  
139 motivation in PE, are changed through intervention. The current research will, therefore, provide  
140 evidence that the key constructs of the model can be changed through intervention, and mediate  
141 effects of the intervention on students' out-of-school physical activity participation. In doing so, it may  
142 signpost a potentially effective strategy by which PE teachers can support autonomous motivation  
143 toward in-school and out-of-school physical activity, which may be useful to promote ongoing physical  
144 activity participation in high school students.

**145 The Present Study**

146 The purpose of the present study was to test the efficacy of a school-based intervention to  
147 promote autonomous motivation towards in-class and out-of-school physical activity on key motivational  
148 and behavioral variables for physical activity in a leisure-time context based on the motivational  
149 sequence specified in the trans-contextual model. We expected the autonomy-supportive intervention  
150 to account for changes in psychological variables across baseline prior to the intervention and at follow-  
151 up post intervention. We also expected the intervention to account for changes in leisure-time physical

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152 activity behavior at follow-up while controlling for baseline leisure-time physical activity behavior.  
153 Overall, we therefore expected changes in the psychological variables specified in the trans-contextual  
154 model to mediate the effects of the autonomy-supportive intervention in PE on changes in physical  
155 activity intentions and behavior in a leisure-time context. As a consequence, we propose that the  
156 intervention effects are modelled as predictors of change in key constructs of the trans-contextual  
157 model. Model constructs should, therefore, serve to mediate effects of an autonomy-supportive  
158 intervention on participation in leisure-time physical activity.

159 In terms of specific hypotheses, we expected the intervention to affect students' leisure-time  
160 physical activity behavior mediated by changes in the variables specified in motivational sequence of  
161 the trans-contextual model. Specifically, we expected the intervention to have effects on changes in  
162 perceived autonomy support in PE, and, through this variable, affect changes in autonomous motivation  
163 in PE. In addition, we expected trans-contextual effects of changes in autonomous motivation in PE to  
164 changes in autonomous motivation in leisure time, consistent with the core hypothesis of the model. We  
165 also expected changes in autonomous motivation to impact changes in leisure-time physical activity  
166 intentions and actual leisure-time physical activity behavior through the belief-based social cognitive  
167 constructs from the theory of planned behavior. Specifically, we expected changes in autonomous  
168 motivation in leisure time to be related to changes in intentions via changes in attitudes and perceived  
169 behavioral control, and that changes in intentions would predict physical activity behavior. Overall,  
170 therefore, we expected statistically significant indirect effects of the intervention and perceived  
171 autonomy support in PE on physical activity behavior via the sequence in the model. We expected  
172 these proposed effects to hold while controlling for demographic variables (gender, age) and past  
173 leisure-time physical activity behavior measured at baseline.

## 174 **Method**

### 175 **Sample and Procedure**

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176           The study conformed to Aristotle University of Thessaloniki[University identity masked for peer  
177 review] Code of Ethics in Research. Two hundred eighty-one junior high school students took part in  
178 the present study. Of those two hundred fifty-six provided valid data in both measurement points (*M*  
179 age = 13.46; *SD* = .82, males = 120, females = 129, unreported = 7). The remaining students did not  
180 complete the questionnaires in one of the measurement points due to absence from the school the data  
181 collection days. Students were recruited from two typical co-educational high schools in an urban city in  
182 Northern Greece. Both schools were located in the same educational region and the students were of  
183 similar socio-demographic background. Students completed a battery of questionnaires on two  
184 measurement occasions; before and immediately after the completion of the intervention. The  
185 autonomy-supportive training lasted 10 weeks; two lessons per week. In each measurement occasion,  
186 a two-wave prospective design, similar to the one typically used in TCM research, was employed. In the  
187 first wave of data collection, students completed the measures pertaining to the TPB variables,  
188 motivational regulations in leisure-time, and past behavior. In the second wave of data collection,  
189 conducted three weeks after the first wave, measures of perceived autonomy support, motivational  
190 regulations in PE, and self-reported physical activity behavior were administered. Before questionnaire  
191 administration permission from school principals and parents was obtained. Parents received a pre-  
192 print form describing the purpose of the study; parents who did not wish their child to complete the  
193 questionnaire or take part in the intervention should sign the form and return it to school. No signed  
194 forms were returned. Students were informed that they will participate in a survey on students' beliefs  
195 about the PE lessons. They were not informed about participation in an intervention study in order to  
196 minimize potential Hawthorne-type effects (i.e., modification of behavior as a result of the awareness of  
197 being observed; McCarney et al., 2007). The questionnaires were completed in quiet classroom  
198 conditions supervised by a trained research associate and without the presence of their PE teacher.  
199 Students were informed that the questionnaire was anonymous and were reassured of the  
200 confidentiality of their responses and that they would be used solely for research purposes. Students

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201 were matched across waves and measurement points based on their class, gender and date of birth.  
202 The study was carried out the spring semester of the 2014-2015 academic season. The timeline of the  
203 study design and data collection is presented in Figure 1.

#### 204 **Measures**

205 A battery of measures was used to assess perceived autonomy support, motivational  
206 regulations in PE and in leisure-time, and students' social cognition towards leisure-time physical  
207 activity. All scales have been used previously with Greek students and demonstrated adequate  
208 psychometric properties.

209 **Perceived autonomy support.** Students' perceptions of teacher-initiated support were  
210 measured with Perceived Autonomy Support Scale for Exercise Settings (PASSES; Hagger et al.  
211 2007). The PASSES comprises 12 items representing respective autonomy supportive behaviors  
212 during PE classes (example item 'I feel that my PE teacher provides me with choices, options, and  
213 opportunities to do active sports and/or vigorous exercise'). Hagger et al. (2007) provided evidence on  
214 the validity of the scale and Barkoukis and Hagger (2013) used this scale with Greek high school  
215 students. Students responded on a 7-point scales ranging from 1 ('strongly disagree') to 7 ('strongly  
216 agree'). The scale demonstrated adequate internal consistency.

217 **Motivational regulations in PE.** The PE version of Perceived Locus of Causality Scale (Ryan  
218 & Connell, 1989) was used to assess students' motivational regulations in PE. The scale includes four  
219 motivational regulations, two autonomous: intrinsic motivation (e.g. "...it is fun") and identified regulation  
220 (e.g. "...I value PE"), and two controlled: introjected regulation (e.g. "...I will feel ashamed if I do not do  
221 PE"), and external regulation (e.g. '...important others want me to do PE'). Participants responded to  
222 the stem question 'I participate in PE because...' on a 4-point Likert scale ranging from 1 ('not true at  
223 all') to 4 ('very true').

224 **Motivational regulations in leisure-time.** Students' motivational regulations in leisure time  
225 physical activity were assessed with the Behavioral Regulations in Exercise Questionnaire (Mullen

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226 Markland, & Ingledew, 1997). Participants responded to the stem question 'Why do you participate in  
227 active sports and/or vigorous physical activities in your leisure time?' followed by 15 items measuring  
228 four motivational regulations; intrinsic motivation (e.g. '...because it is fun'), identified regulation (e.g.  
229 '...because it is important to make the effort'), introjected regulation (e.g. '...because I will feel guilty if I  
230 do not'), and external regulation (e.g. '...because others say I should'). Responses were anchored on a  
231 7-point Likert scale ranging from 1 ('not true at all') to 7 ('very true'). In order to reduce the number of  
232 constructs in subsequent analyses and develop more parsimonious model a relative autonomy index  
233 (RAI) was calculated for both the PE and LTPA measures of motivation based on Vallerand's (2007)  
234 recommendations (i.e.,  $2 \times$  intrinsic motivation + identified regulation - introjected regulation -  $2 \times$   
235 external regulation). The RAI was used in all subsequent analyses.

236 **Theory of Planned Behavior variables.** The TPB variables in the present study were  
237 assessed based on the recommendations of Ajzen (2002) and previous research with the TCM (e.g.,  
238 Barkoukis & Hagger, 2013). The measure of attitudes included five semantic differential scales with the  
239 bipolar adjectives: bad-good, harmful-beneficial, not enjoyable-enjoyable, useful-useless and boring-  
240 interesting. Students responded to the stem question: 'Participating in active sports and/or vigorous  
241 physical activities during my leisure-time in the next five weeks is...' and responses were coded on a 7-  
242 point scale. Subjective norms were assessed with two items (e.g., 'People important to me think that I  
243 should do active sports and/or vigorous physical activities during my leisure-time in the next 5 weeks')  
244 with students recording their responses on a 7-point scale ranging from 1 ('strongly disagree') to 7  
245 ('strongly agree'). PBC was measured with three items (e.g., "I feel in complete control over whether I  
246 do active sports and/or vigorous physical activities in my leisure-time in the next 5 weeks") with  
247 responses anchored on a 7-point Likert scale ranging from 1 ('no control') to 7 ('complete control').  
248 Intentions were assessed with three items (e.g., "I intend to do active sports and/or vigorous physical  
249 activities during my leisure-time in the next 5 weeks...") rated on seven-point scales anchored by 1  
250 ("strongly disagree") to 7 ("strongly agree").

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251           **Physical activity behavior.** Godin and Shephard's (1985) Leisure-Time Exercise  
252    Questionnaire was used to measure students' self-reported leisure-time physical activity participation.  
253    The following definition of vigorous physical activity was provided to students: "Vigorous physical  
254    activities are activities which make your heart beat faster, breathe faster, and hot and sweaty".  
255    Participants then were asked to record their 5-week physical activity participation during their leisure-  
256    time on two items (e.g., "In the course of the past five weeks, how often have you participated in  
257    vigorous physical activities for 20 minutes at a time?") using six-point Likert scales ranging from 1  
258    ('never') to 6 ('everyday').

259           **Past behavior.** A single-item used in past TCM research (Barkoukis & Hagger, 2013; Hagger  
260    et al. 2003) was used to measure participants' past physical activity behavior (i.e., 'In the course of the  
261    past six months, how often, on average, have you participated in vigorous physical activities for 20  
262    minutes at a time?'). Participants recorded their physical activity participation on a 6-point Likert scale  
263    ranging from 1 ('not at all') to 6 ('most days per week').

### 264    **Intervention Design**

265           Two schools were randomly assigned to receive the autonomy-support intervention or control  
266    intervention. The school assigned to receive the autonomy-supportive intervention comprised five  
267    classes of students (total  $n = 131$ ; 63 males and 61 females, 7 students did not report their gender;  $M$   
268    age = 13.26 years,  $SD = .84$ ). The school assigned to receive the control intervention also comprised  
269    five classes (total  $n = 125$  students; 57 males and 68 females,  $M$  age = 13.65 years,  $SD = .76$ ). The PE  
270    teacher in the school assigned to receive the autonomy-supportive intervention (male, 43 years old, 14  
271    years of experience in secondary education) attended a series of 3 seminars lasting 1.5 hours each  
272    over a period of 2 weeks. The first session included a description of key concepts from self-  
273    determination theory and their interplay in establishing an adaptive social environment that will result in  
274    students adopting adaptive behaviors in the school context (e.g., relations between autonomy  
275    supportive climate and intrinsic motivation). The second session included instruction on how to adopt

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276 strategies that promote autonomy in students (e.g., providing choice, adopting active listening,  
277 encouraging student-generated questions, allowing students to work independently, providing a  
278 meaningful rationale, providing informational feedback, offering hints, responding to student-generated  
279 questions). The third session included instruction on strategies on how to avoid fostering a controlling  
280 climate (e.g., avoiding use of controlling language (e.g., “should”, “must” and “got to”, avoiding giving  
281 solutions verbatim, avoiding use of directives and commands) (see Reeve & Jang, 2006; Teixeira et al.,  
282 2020). All three sessions were interactive emphasizing discussion of examples from everyday life,  
283 demonstrating how to promote interaction with students during lessons, and discussing solutions to  
284 existing or anticipated situations during the implementation of the intervention (e.g., number of choices,  
285 types of choices in each subject). The PE teacher of the school assigned to receive in the autonomy-  
286 supportive intervention was then instructed to apply this training to his regular PE lessons for a period  
287 of 10 weeks. For example, during the warm-up phase, the PE teacher offered students choice with  
288 respect to the type of warm-up activity or was allowed students to do their own stretching exercises. In  
289 addition, the PE teacher was explaining the content of the lesson, providing rationales for the selected  
290 activities. In the main part of the lesson, practice and inclusion teaching styles were endorsed allowing  
291 students to work at their own pace. Furthermore, on several occasions, students were asked to choose  
292 among similar drills to perform, or chose the order of the drills to be performed. Also, depending on the  
293 content of the lesson, goal setting was fostered. At the end of the lesson a few minutes were devoted to  
294 asking questions to students about their experiences in the lesson (see Table 1 for example strategies).  
295 The PE teacher of the school assigned to receive the control intervention (male, 45 years old, 17 years  
296 of experience in secondary education) was told that his school was selected to participate in a study  
297 investigating the short term effects of PE lessons on students’ beliefs about the lesson and received no  
298 training on self-determination or promotion of autonomy supportive climate. The PE teacher was asked  
299 to teach their normal PE lessons for a period of 10 weeks. An informal discussion with the PE teacher  
300 after the completion of the second measurement point revealed that he did not change his teaching

301 approach. Lesson content in both schools was guided by the national curriculum for PE (see  
302 Tsorbatzoudis, Grouios, Barkoukis & Alexandris, 2007). Both teachers taught the same sport activities  
303 (i.e., basketball, football, track and field), and Greek traditional dances, but the order of the subjects or  
304 the specific dances taught and the time devoted to each activity, was slightly different depending on the  
305 school facilities, weather, and other conditions.

### 306 **Data Analysis**

307 Descriptive statistics and reliability analyses were computed using the *psych* package (Revelle,  
308 2018) in R. We tested hypotheses of our proposed model by path analysis conducted using the *lavaan*  
309 package (Rosseel, 2012) in R using a maximum likelihood estimation method<sup>1</sup>. We also estimated  
310 bootstrapped standard errors with 1000 replications, consistent with recommendations (Hayes, 2018).  
311 Missing data was imputed using the full-information maximum likelihood method (FIML)<sup>2</sup>. As more than  
312 95% of cases were retained across the baseline and follow-up time points of the intervention, attrition  
313 analyses were redundant. All the psychological and behavioral variables in the model were represented  
314 as change variables. The change variables were computed as residualized change scores derived from  
315 the regression of the follow-up measure of the variable on its baseline value. The hypothesized  
316 relations among the variables in the proposed model are summarized in Figure 2. The pattern of  
317 proposed effects followed hypotheses derived from the trans-contextual model. The effects of the  
318 intervention were tested by predicting leisure-time physical activity at follow-up, the primary dependent  
319 variable, changes in intention, and changes in perceived autonomy support by a dichotomous  
320 intervention variable coded as 1 = control intervention and 2 = autonomy-supportive intervention.  
321 Gender, age, and leisure-time physical activity behavior at baseline were included as control variables  
322 which predicted all other variables in the model. Age and baseline physical activity behavior, were  
323 included as continuous control variables and gender was included as a dichotomous control variable.

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<sup>1</sup>Data files, analysis scripts, and output from the data analysis including reliability, statistical power, and path analyses are available online: <https://osf.io/b4t9c>

<sup>2</sup>Path analyses were conducted without FIML imputation, patterns of effects were unchanged, full results are available online: <https://osf.io/b4t9c>



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324 Adequacy of the hypothesized model was established using the goodness-of-fit chi-square, the  
325 comparative fit index (CFI), with values exceeding .95 typically considered appropriate cutoff values for  
326 adequate model fit, the standardized root mean squared residuals with a cutoff value of 0.500 taken as  
327 indicating a well-fitting model, and the root mean squared error of approximation (RMSEA) and its 90%  
328 confidence intervals (CI<sub>90</sub>) with a cutoff value equal to or less than .08 and narrow confidence intervals  
329 indicative of an adequately-fitting model (Marsh, Hau, & Wen, 2004). Hypothesized mediation effects  
330 were tested by calculating indirect effects with bootstrapped standard errors.

### 331 Results

332 Descriptive statistics, reliability coefficients<sup>3</sup>, and zero-order correlation coefficients among study  
333 variables are reported in Table 2. Reliability coefficients revealed acceptable reliabilities for all  
334 constructs at each time point. Exceptions were the autonomous motivation in PE (relative autonomy  
335 index) scale at baseline and follow-up and the subjective norm scale at baseline. Standardized  
336 parameter estimates for the path analysis among the proposed model constructs are presented in  
337 Figure 3. Overall, the model exhibited adequate fit with the data ( $\chi^2(18) = 44.390, p = .001$ ; CFI = .956;  
338 SRMSR = .045; RMSEA = .078, RMSEA CI<sub>90</sub> upper limit = .049, RMSEA CI<sub>90</sub> lower limit = .107). In  
339 addition, the model accounted for a statistically significant amount of variance in the key dependent  
340 variables: follow-up leisure-time physical activity ( $R^2 = .451$ ), changes in intentions ( $R^2 = .439$ ), and  
341 changes in perceived autonomy support ( $R^2 = .210$ ). In addition, a posteriori statistical power analysis  
342 for the final model was conducted to ensure the final model had the requisite power. Our analysis was  
343 based on MacCallum, Browne, and Sugawara's (1996) method based on the RMSEA and implemented  
344 using the *Webpower* tool (Zhang & Yuan, 2018). Based on input parameters recommended for a  
345 conservative estimate ( $N = 271, H1$  RMSEA = .078,  $H0$  RMSEA = .000,  $df = 18, p = .001$ ), the  
346 reproduced statistical power was .851.

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<sup>3</sup>Where possible Omega reliability coefficients (Revelle & Zinbarg, 2008) were computed. For two-item scales, the Spearman-Brown inter-item correlation was computed. For the relative autonomy index in leisure time at baseline, the Omega reliability calculation did not converge due a non-positive definite matrix, so the standard Cronbach alpha is reported.

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347 Results revealed no statistically significant effects of the intervention on follow-up leisure-time  
348 physical activity ( $\beta = .049, p = .329$ ) and changes in intentions ( $\beta = -.024, p = .637$ ). Unsurprisingly,  
349 there was a significant large-sized effect of the intervention on changes in perceived autonomy support  
350 ( $\beta = .466, p < .001$ ). There were statistically significant direct effects of changes in perceived autonomy  
351 support on changes in autonomous motivation in PE ( $\beta = .188, p = .002$ ) and changes in autonomous  
352 motivation in leisure time ( $\beta = .117, p = .044$ ), with small effect sizes. There was also a statistically  
353 significant direct effect of changes in autonomous motivation in leisure time on changes in PBC ( $\beta =$   
354  $.318, p = .025$ ) as hypothesized with a small-to-medium effect size. Contrary to hypotheses, we found  
355 a statistically significant negative direct effect of changes in autonomous motivation in leisure time on  
356 changes in subjective norms ( $\beta = -.386, p < .001$ ) with a small-to-medium effect size. Changes in  
357 intentions were predicted by changes in PBC ( $\beta = .610, p < .001$ ) with a medium-to-large effect size, as  
358 hypothesized. But there was not effect of changes in attitudes ( $\beta = .039, p = .489$ ) or subjective norms  
359 ( $\beta = .106, p = .069$ ) on intentions, contrary to hypotheses. Changes in intentions predicted participation  
360 in leisure time physical activity ( $\beta = .559, p < .001$ ) with a medium-to-large effect size.

361 In terms of indirect effects, we found statistically significant indirect effects of the intervention on  
362 changes in autonomous motivation in PE via changes in perceived autonomy support ( $\beta = .087, p =$   
363  $.003$ ) with a small effect size. We also found statistically significant indirect effects of the intervention on  
364 changes in autonomous motivation in leisure time via changes in perceived autonomy support and  
365 changes in autonomous motivation in PE ( $\beta = .038, p = .005$ ) with a small effect size. There was also  
366 an indirect effect of the intervention on autonomous motivation in leisure time via changes in perceived  
367 autonomy support alone which fell marginally short of the conventional level for statistical significance  
368 ( $\beta = .055, p = .052$ ), again, with small effect sizes. Together these resulted in a small, statistically  
369 significant total indirect effect of the intervention on changes in autonomous motivation in leisure time ( $\beta$   
370  $= .093, p = .004$ ). There were, however, no indirect effects of the intervention on changes in intention or  
371 physical activity behavior. We also found a statistically significant indirect effect of changes in perceived

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372 autonomy support in PE on changes in autonomous motivation in leisure time through changes in  
373 autonomous motivation in PE ( $\beta = .082, p = .004$ ) with a small effect size, consistent with hypotheses.  
374 There was also a statistically significant indirect effect of changes in autonomous motivation in leisure-  
375 time on changes in intentions through changes in perceived behavioral control ( $\beta = .194, p = .036$ ), with  
376 a small-to-medium effect size, as predicted, but not through attitudes and subjective norms leading us  
377 to reject these hypotheses. There was a statistically significant indirect effect of changes in perceived  
378 behavioral control ( $\beta = .342, p < .001$ ) with a small-to-medium effect size via changes in intentions on  
379 leisure time physical activity as hypothesized, but not for attitudes or subjective norms, leading us to  
380 reject this hypothesis. There was also a statistically significant indirect effects of changes in  
381 autonomous motivation in leisure-time on leisure time physical activity via changes in perceived  
382 behavioral control and intentions ( $\beta = .109, p = .048$ ) with a small effect size.

### 383 Discussion

384 The purpose of the present study was to test the effectiveness of a school-based intervention to  
385 promote an autonomy-supportive motivational climate in PE in promoting intentions toward, and actual  
386 participation in, leisure-time physical activity behavior outside of school. The study was guided by the  
387 trans-contextual model which identified the psychological processes by which the intervention was  
388 expected exert its effects on out-of-school leisure-time physical activity intentions and behavior. In the  
389 study, students in classes in two schools received either an autonomy-supportive intervention or a  
390 control intervention with random assignment at the school level. The PE teacher of the school assigned  
391 to receive the autonomy-supportive intervention received a three-seminar interactive program providing  
392 them with training to promote autonomy support to students in PE lessons. The teacher in the school  
393 assigned to receive the control intervention did not receive the training program. The intervention lasted  
394 10 weeks. During the intervention, each teacher taught their normal PE lessons concurrent to the  
395 training. Results indicated that students in the school allocated to receive the autonomy-supportive  
396 intervention reported significantly greater levels of perceived autonomy support and, indirectly,

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397 autonomous motivation in PE, and autonomous motivation outside of school at post-intervention follow-  
398 up. However, there were no direct effects of the intervention on students' intentions to engage in  
399 physical activity, and actual physical activity behavior. There were statistically significant effects on  
400 perceived autonomy support on autonomous motivation in PE and leisure time, and on intentions to be  
401 physically active through autonomous motivation and perceived behavioral control, but these variables  
402 did not transmit the effects of the intervention on actual physical activity participation.

403         Current results have important ramifications for the trans-contextual model as a model of  
404 prediction and a model that guides intervention. As a model of prediction, current results support many  
405 of the premises of the model. That is, the major premises of the model are supported i.e. perceived  
406 autonomy support from teachers in PE contexts predicted students' autonomous motivation in PE,  
407 autonomous motivation toward engaging in physical activity in leisure time, and students' intentions to  
408 engage in leisure-time physical activity. Results are, therefore, largely consistent with previous  
409 prospective tests of the model (Barkoukis & Hagger, 2013; Hagger et al., 2003, 2005; 2009), along with  
410 review (Barkoukis & Hagger, 2012; Hagger & Chatzisarantis, 2012) and meta-analytic (Hagger &  
411 Chatzisarantis, 2016) evidence supporting the major premises of the model, including the indirect  
412 effects across contexts, which are central to the model. PE teachers are encouraged to use autonomy  
413 supportive practices such as providing rationales, allowing students to work on their own pace,  
414 providing opportunities for interaction with the students and being responsive to their question, avoiding  
415 use of controlling language (e.g., "should", "must" and "got to"), avoiding giving solutions verbatim,  
416 avoiding use of directives and commands, and avoiding asking controlling questions (see Reeve, 2016;  
417 Reeve & Jang, 2006). As our study showed, these practices can increase students' perceptions of an  
418 autonomy supportive motivational climate and influence, therefore, their beliefs towards PE lesson and  
419 leisure-time physical activity.

420         However, as a model that guides intervention to change motivation, intentions, and actual  
421 participation in physical activity behavior outside of school, current findings only support the

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422 effectiveness of model in promoting change in perceived autonomy support and autonomous  
423 motivation, but not intentions and physical activity behavior outside of school. Given the consistency  
424 and strength of the trans-contextual effects found in previous research of perceived autonomy support  
425 and autonomous motivation in a PE context on autonomous motivation, intentions, and actual physical  
426 activity engagement in a leisure-time context, it stands to reason that an intervention that evokes  
427 change in the constructs in PE may lead to trans-contextual effects on motivation and behavior outside  
428 of school. The current intervention was specifically designed to change the key PE variables that have  
429 been shown to relate to out-of-school behavior using an intervention that promotes an autonomy-  
430 supportive motivational climate, and compare effects with an appropriate “no training” comparison (c.f.,  
431 Cheon et al., 2012; Reeve & Jang, 2006). While the autonomy-supportive intervention was effective in  
432 promoting greater perceived autonomy support and autonomous motivation, consistent with previous  
433 research on autonomy-supportive climates (e.g., Cheon et al., 2012), and in changing autonomous  
434 motivation in an out-of-school leisure-time physical activity context, the effects were relatively weak and  
435 were not transmitted to intentions to engage in, and actual participation in, subsequent leisure-time  
436 physical activity behavior. This is inconsistent with a previous intervention deriving its hypotheses from  
437 the trans-contextual model, which showed significant effects of a school-based intervention on leisure-  
438 time physical activity behavior through the mediators proposed in the model (Chatzisarantis & Hagger,  
439 2009).

440         Possible reasons why the current intervention had little effect may be that the changes made to  
441 the practice of the teacher may have been insufficiently strong to lead to changes in out-of-school  
442 physical activity, despite changes in out-of-school autonomous motivation. In other words, the  
443 intervention effects were not sufficiently powerful to have an effect on physical activity behavior in  
444 leisure time, an activity that is distal to PE. Instead, physical activity likely to be subject to more  
445 proximal factors that influence behavioral engagement including motivational and social cognition  
446 constructs like perceived autonomy support for physical activity outside of school from parents and

447 peers, attitudes and beliefs toward physical activity, and self-efficacy and socio-ecological factors like  
448 access to facilities and opportunities to act (e.g., González-Cutre et al., 2014b; Olson, Ireland, March,  
449 Biddle, & Hagger, 2019). Another possible reason is that the changes in PE teacher's practice were  
450 perhaps modest or not maintained in the current intervention relative to others. This may have been  
451 because teacher's training was relatively brief and of low intensiveness relative to previous  
452 interventions. For example, Chatzisarantis and Hagger's autonomy-support training program involved  
453 training of teachers for a total of 3 days training with 3-hour sessions and over a period of 5 weeks,  
454 similar to other autonomy-support interventions (e.g., Cheon et al., 2012; Polet et al., 2019). In contrast,  
455 the current intervention was less intense with a total of 4.5 hours training over a period of a week. The  
456 intensiveness and duration of training is likely to be a moderator of the effectiveness of autonomy  
457 supportive interventions, particularly the strength of the effects and the likelihood that it will pervade into  
458 other contexts. Based on meta-analytic evidence that minimal autonomy support interventions with brief  
459 training experience are the least effective in changing autonomous motivation and behavior (Su &  
460 Reeve, 2011), there is strong advocacy that autonomy-support interventions to change the behavior of  
461 social agents creating motivational climates in educational settings involves multiple exposures over a  
462 period of six weeks with reinforcement and feedback on autonomy supportive techniques (Cheon et al.,  
463 2012). The relatively brief nature of the teachers' training, therefore, may explain the lack of effects on  
464 actual behavior across contexts in the current study.

#### 465 **Strengths, Limitations, and Proposals for Future Research**

466 The current study has numerous strengths including: targeting an important research question,  
467 namely, whether fostering students' autonomous motivation in PE will lead to physical activity  
468 motivation and behavior outside of school in a leisure time context; the adoption of an appropriate  
469 integrated multi-theory model to guide the development of the intervention and map the processes by  
470 which the intervention exerts effects across PE and leisure-time contexts; the recruitment of a large  
471 sample of students and recruiting PE teachers willing to make changes to their interpersonal style and

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472 motivational climate in lessons; the use of previously-validated techniques to foster autonomy-  
473 supportive styles in teachers; the use of an intervention design with autonomy-support and control  
474 intervention conditions with random allocation by school; and the use of validated measures of  
475 psychological mediators of intervention effects and path analytic models using residualized change  
476 scores that enabled a test of mediation effects of the model specified a priori while incorporating  
477 change across time of measurement.

478         There are, of course, limitations that must be acknowledged. The primary limitation is the  
479 relatively brief, minimal nature of the teacher training relative to other intervention programs adopted in  
480 previous studies (e.g., Chatzisarantis & Hagger, 2009; Cheon et al., 2012), an issue to which we  
481 alluded to in our previous discussion. A further limitation is the adoption of a self-report measure of  
482 physical activity behavior. Although our measure has demonstrated statistically significant correlations  
483 against more objective measures of physical activity in previous studies, there is still considerable  
484 potential for response bias introducing substantive measurement error into the current analysis. We  
485 also did not account for the potential of clustering of students within classes within the two schools.  
486 While there is potential for there to be higher likelihood of similar responding to measures within-  
487 classes rather than between classes, the current study was underpowered to estimate a multilevel  
488 model that tested within-class variation alongside between-class variation. However, given that the  
489 number of classes was small ( $n = 5$ ) and all classes were taught by the same teacher, we expect that  
490 the within-class variability component would have been relatively modest. However, conducting an  
491 autonomy-support intervention that enables analyses that account for within-participants effects would  
492 be an important avenue for future research. It is also important to note that not all scales for the  
493 measures used in the current study exhibited acceptable reliability. Specifically, the autonomous  
494 motivation in PE scale at baseline and follow-up and the subjective norm scale at baseline were below  
495 acceptable cutoff values. While the current path analytic models aimed to correct for error in prediction,  
496 there was some measurement error associated with these constructs as a full latent variable model was

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497 not able to be estimated. Current findings should therefore be interpreted with the compromised  
498 reliability in mind, which has the potential to inflate or suppress model relations involving these  
499 constructs. A final limitation is that we did not provide a formal evaluation of the extent to which the PE  
500 teacher receiving the autonomy-supportive training and the teacher that received no training differed in  
501 the autonomy-supportive behaviors they adopted in their lessons before and after the intervention. This  
502 means that a formal evaluation of the fidelity of the intervention, i.e. whether participating teachers had  
503 actually followed the protocol and resulted in actual changes in their behavior could not be conducted.  
504 This would make the current study much stronger by providing evidence that the intervention led to  
505 changes in key behaviors expected to foster autonomous motivation in students. Future research  
506 needs to adopt autonomy supportive training programs of extended duration to promote strong effects,  
507 use validated, objective measures of leisure-time physical activity such as accelerometers, and include  
508 formal tests of intervention fidelity such as observation of teachers' behavior during lessons for key  
509 autonomy-supportive behaviors.



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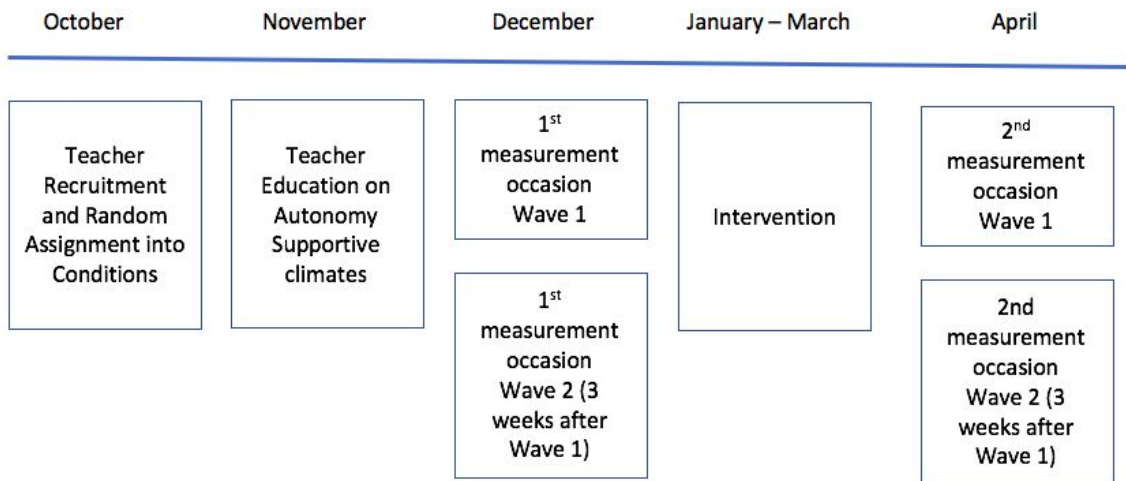
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732 *Figure 1.* Timeline of the study design and data collection.

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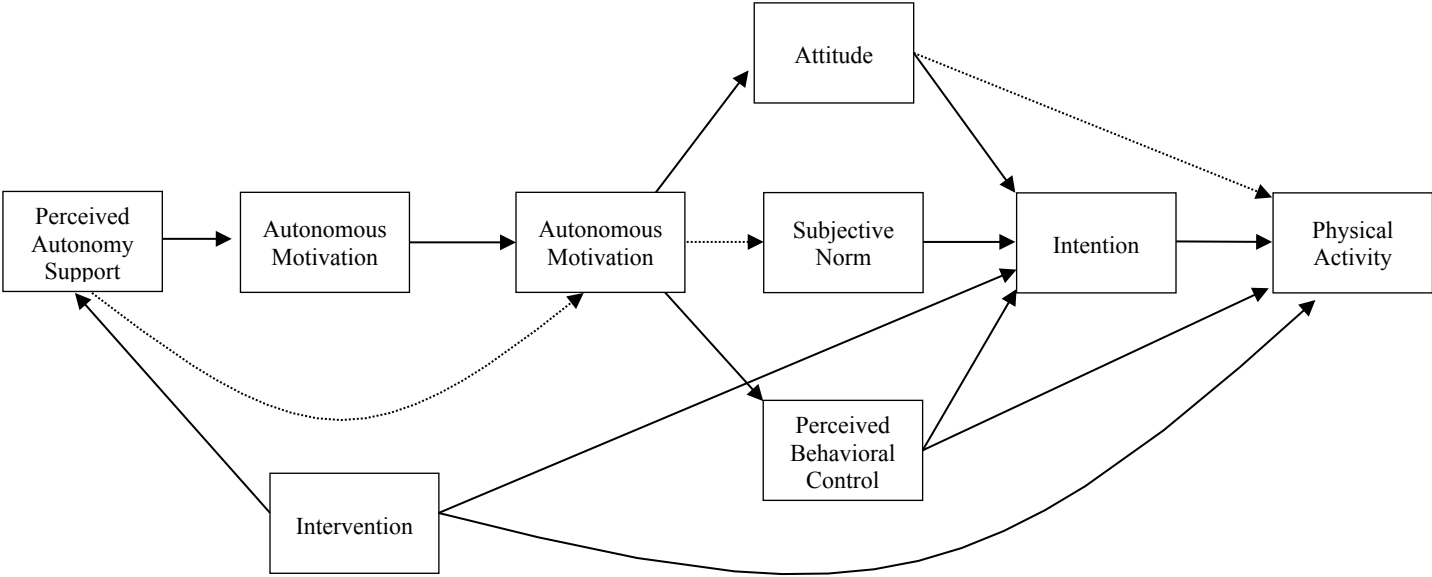
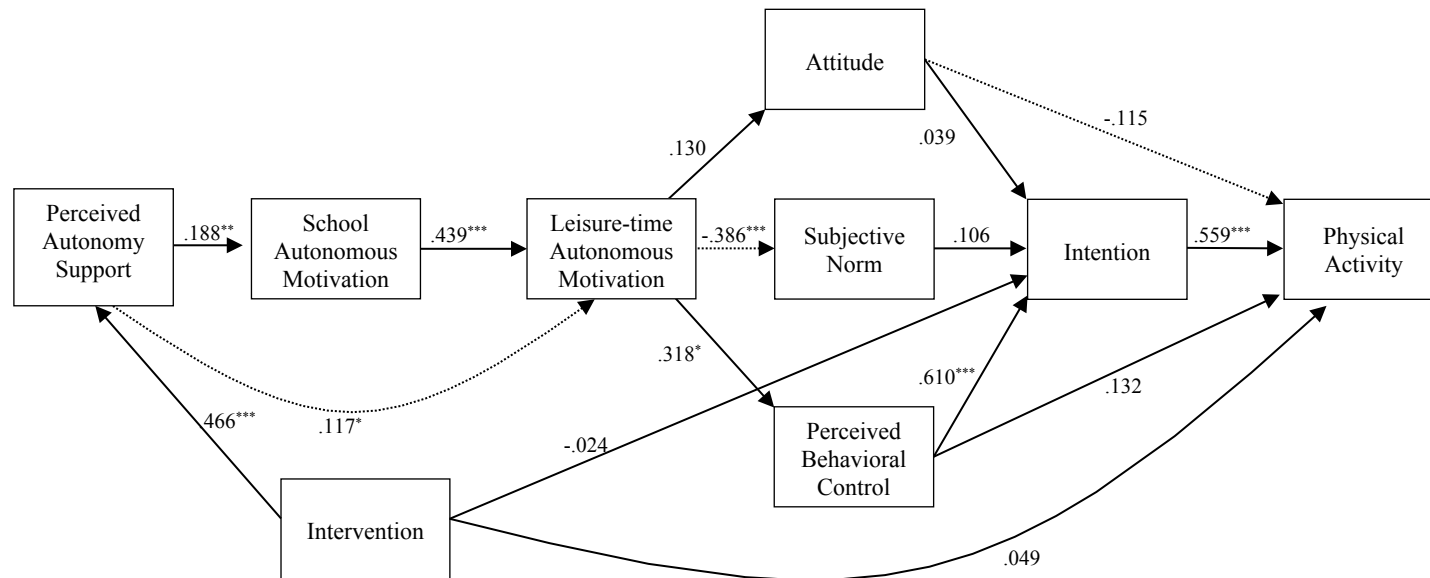


Figure 2. Proposed model illustrating effects of the trans-contextual model intervention on leisure-time physical activity and model constructs. Effects of gender, age, and past physical activity behavior as control variables on each variable in the model omitted for clarity.

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*Figure 3.* Standardized parameter estimates of effects in the path analytic model of the trans-contextual model intervention effects. Psychological variables (intention, attitude, subjective norm, perceived behavioral control, autonomous motivation in leisure time and school contexts, and perceived autonomy support) are residualized change scores derived from the regression of each variable at follow-up on itself at baseline. Statistically significant specific indirect effects not shown in model: Intervention→Perceived autonomy support→Autonomous motivation in PE ( $\beta = .087, p = .003$ ); Intervention→Perceived autonomy support→Autonomous motivation in leisure time ( $\beta = .077, p = .004$ ); Perceived autonomy support→Autonomous motivation in PE→Autonomous motivation in leisure time ( $\beta = .082, p = .004$ ); Autonomous motivation in leisure time→Perceived behavioral control→Intention ( $\beta = .194, p = .036$ ); Perceived behavioral control→Intention→Physical activity behavior ( $\beta = .342, p < .001$ ); Autonomous motivation in leisure time→Perceived behavioral control→Intention→Physical activity behavior ( $\beta = .109, p = .048$ );. Statistically significant total effects: Perceived autonomy support→Autonomous motivation in leisure time ( $\beta = .199, p = .004$ ); Intervention→Autonomous motivation in leisure time ( $\beta = .093, p = .004$ ); Perceived behavioral control→Physical activity behavior ( $\beta = .474, p < .001$ ). Effects of gender, age, 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→Perceived autonomy support ( $\beta = .022, p = .712$ ); Gender→Autonomous motivation in PE ( $\beta = .185, p = .005$ ); Gender→Autonomous motivation in leisure time ( $\beta = .013, p = .838$ ); Gender→Attitude ( $\beta = -.003, p = .968$ ); Gender→Subjective norms ( $\beta = -.153, p = .021$ ); Gender→Perceived behavioral control ( $\beta = -.131, p = .052$ ); Gender→Intention ( $\beta = .005, p = .929$ ); Gender→Physical activity ( $\beta = -.070, p = .171$ ); Age→Perceived autonomy support ( $\beta = .166, p = .013$ ); Age→Autonomous motivation in PE ( $\beta = .082, p = .174$ ); Age→Autonomous motivation in leisure time ( $\beta = .080, p = .157$ ); Age→Attitude ( $\beta = -.048, p = .534$ ); Age→Subjective norms ( $\beta = -.081, p = .188$ ); Age→Perceived behavioral control ( $\beta = -.055, p = .469$ ); Age→Intention ( $\beta = .005, p = .929$ ); Age→Physical activity ( $\beta = .058, p = .222$ ); Past physical activity behavior→Perceived autonomy support ( $\beta = -.003, p = .962$ ); Past physical activity behavior→Autonomous motivation in PE ( $\beta = .052, p = .450$ ); Past physical activity behavior→Autonomous motivation in leisure time ( $\beta = -.008, p = .885$ ); Past physical activity behavior→Attitude ( $\beta = .023, p = .767$ ); Past physical activity behavior→Subjective norms ( $\beta = .098, p = .098$ ); Past physical activity behavior→Perceived behavioral control ( $\beta = .027, p = .700$ ); Past physical activity behavior→Intention ( $\beta = .053, p = .300$ ); Past physical activity behavior→Physical activity ( $\beta = .122, p = .018$ ).

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

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Table 1

*Example Content of Autonomy-Supportive Strategies*

Theme and focus	Example content
Student motivation and autonomy support	Offering choices to students on various aspects of the lesson. Allowing students work determine the pace of the lesson. Providing rationale for the structure of the lessons and the choice of exercises.
Developing social interactions	Opportunities for students to work in small groups. Opportunities for students to work in multiple groups. Reciprocal teaching style.
Recognition and praise	Recognition to all students. Recognition of motor performance as well as effort and interest towards the lesson.
Developing a sense of competence	Emphasis on personal development. Opportunities for students to work on their own pace. Goal setting. Inclusion teaching style.
Avoiding control: Maintaining autonomy support	Avoiding exhibiting solutions/answers, monopolizing learning materials, uttering solutions/answers, setting deadlines, uttering directives/commands, asking controlling questions, emphasizing students' obligations, using judgmental language and criticizing the students

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Table 2

Zero-Order Intercorrelations and Reliability Coefficients for Study Variables

Variable	$\omega^a$	$M^b$	$SD^b$	1	2	3	4	5	6	7	8	9	10	11	12
1. Perceived autonomy support	.931	4.691	1.056	–											
	.931	5.268	0.915												
2. Autonomous motivation (PE)	.583 <sup>c</sup>	2.016	2.413	.179**	–										
	.508 <sup>c</sup>	2.052	2.417												
3. Autonomous motivation (LT)	.830 <sup>d</sup>	7.538	4.642	.235**	.484***	–									
	.900	6.947	5.111												
4. Attitude	.878	4.803	0.966	.165*	.126	.175	–								
	.867	4.908	0.873												
5. Subjective norm	.484 <sup>c</sup>	4.020	1.517	.161**	-.087	-.379***	.129*	–							
	.699 <sup>c</sup>	4.048	1.720												
6. Perceived behavioral control	.802	5.381	1.238	.447***	.208**	.236**	.331***	.241***	–						
	.823	5.475	1.235												
7. Intention	.809	4.720	1.463	.269***	.214*	.221**	.238***	.244***	.658***	–					
	.812	4.762	1.435												
8. Physical activity behavior	–	3.996	1.431	.132*	.277***	.173*	.116	.215***	.487***	.642***	–				
9. Past physical activity behavior	–	4.025	1.414	.000	.055	.019	.034	.097	.070	.089	.197**	–			
10. Gender <sup>e</sup>	–	–	–	-.032	.173*	.157*	.015	-.224***	-.046	-.031	-.113	-.103	–		
11. Age	–	13.432	0.825	.048	.080	.049	-.012	.081	-.018	.034	.050	-.041	-.120	–	
12. Intervention <sup>f</sup>	–	–	–	.437***	.191**	.176**	.091	-.105	.196*	.073	.126	.116	-.038	-.204***	–

Note. PE = Physical education; LT = Leisure-time physical activity. Correlations among psychological constructs are for residualized change scores derived from the regression of the construct at post intervention follow-up on its baseline score. <sup>a</sup>Revelle’s (2019) Omega ( $\omega$ ) reliability coefficient, upper values are for scales at baseline and lower values are for post-intervention follow-up; <sup>b</sup>Descriptive statistics are for averaged scales at each time point, upper values are for scales at baseline and lower values are for post-intervention follow-up; <sup>c</sup>Two item scale so reliability is Spearman-Brown inter-item correlation; <sup>d</sup>Matrix for calculation of  $\omega$  reliability coefficient was not positive definite, so Cronbach alpha reliability coefficient reported; <sup>e</sup>Dichotomous variable coded as 1 = Boy, 2 = Girl; <sup>f</sup>Dichotomous variable coded as 1 = autonomy-support training, 2 = “no training” control. \* $p < .05$  \*\* $p < .01$  \*\*\* $p < .001$



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