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1 **Title:** Including the construct of novelty in a full sequential model of the bright side of self-  
2 determination theory in physical education

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9

10 **Abstract:**

11 The aim of this study was to incorporate the construct of novelty into the sequential model  
12 proposed by self-determination theory, analyzing the paths between teachers' need support  
13 in physical education and students' need satisfaction, autonomous motivation, and intention  
14 to be physically active. Participants in this cross-sectional study were 888 secondary school  
15 students (472 girls), aged between 11 and 17 years ( $M = 13.15$ ). Results from the final  
16 structural equation model showed that each type of teacher need support (i.e. autonomy,  
17 competence, relatedness, and novelty) was most strongly associated with the satisfaction of  
18 its respective need in students. Moreover, teachers' competence and relatedness support were  
19 positively associated with novelty satisfaction. Only competence and novelty satisfaction  
20 were positively related to students' autonomous motivation, which, in turn, was positively  
21 associated with their intention to be physically active. These findings provide further  
22 evidence for considering novelty from a self-determination theory perspective.

23 **Keywords:** Need-supportive teaching style, basic psychological needs, motivation, physical  
24 activity, explanatory role.

## 1 Introduction

2 Self-determination theory (SDT) (Deci & Ryan, 1985; Ryan & Deci, 2017), an empirical  
3 macro-theory of human motivation, posits the existence of three basic psychological needs  
4 (BPNs) within one of its six mini-theories, the BPNs theory. These BPNs are recognized as  
5 psychological nutrients essential to individuals' adjustment, integrity, and growth (Ryan,  
6 1995). The needs established by SDT are autonomy, which is characterized by the experience  
7 of volition, willingness, and authenticity in one's actions, thoughts, and feelings; relatedness,  
8 which pertains to the experience of warmth, bonding, and care, and is fulfilled when feeling  
9 connected to significant others; and competence, which involves the experience of  
10 effectiveness and mastery (Vansteenkiste et al., 2023). The SDT sequential model  
11 (Vasconcellos et al., 2020) establishes that the social context affects BPN satisfaction or  
12 frustration. In turn, this satisfaction or frustration will have an impact on human motivation  
13 and its consequences (Ryan & Deci, 2020). From an organismic SDT perspective, physical  
14 activity (PA) can be understood as a natural expression of vitality and human flourishing  
15 (Ryan, 2025). For instance, BPN satisfaction in physical education is associated with  
16 students' autonomous motivation (Kelso et al., 2020) and adaptive consequences such as  
17 positive emotions and the intention to be physically active (e.g. Castillo et al., 2020; Fierro-  
18 Suero et al., 2023). On the other hand, BPN frustration is associated with maladaptive  
19 outcomes such as amotivation, disinterest, or sedentary behaviors (White et al., 2021).

20 Physical education potentially plays a fundamental role in promoting healthy lifestyles and  
21 students' well-being (Kalajas-Tilga et al., 2020). In some cases, it represents the only  
22 guaranteed opportunity for all young people to engage in PA. Moreover, it can offer a  
23 structured environment in which students can acquire motor skills and have opportunities to  
24 develop motivational dispositions and attitudes that might, under certain conditions, extend  
25 to extracurricular sport and exercise participation. Teachers are among the most influential  
26 actors in the educational context (Braithwaite et al., 2011) and can support or thwart students'  
27 BPNs. The teacher's interpersonal style depends on how educational aspects are managed,  
28 including goal-setting, approach to corrections, or interaction with students (Ryan & Deci,  
29 2017). For example, an autonomy-supportive style is characterized by attempts to identify  
30 students' interests and preferences and providing choice (Aelterman et al., 2019; Patall et al.,  
31 2010; Reeve, 2009). Competence support refers to how teachers organize and deliver  
32 activities by providing clear expectations, consistent contingencies, efficacy-relevant  
33 feedback, help when needed, and ongoing monitoring during the lesson (Vasconcellos et al.,  
34 2020), while a relatedness-supportive style refers to promoting authentic and supportive  
35 relationships (Reeve & Jang, 2006). Thus, when teachers establish a need-supportive  
36 interpersonal style, students' motivation, engagement, and learning improve (Cheon et al.,  
37 2018, 2020; Reeve & Cheon, 2021). Conversely, when a teacher adopts a need-thwarting  
38 interpersonal style, students' motivation tends to be more controlled, fear of failure increases,  
39 and engagement decreases (Vasconcellos et al., 2020).

40 The incorporation of new BPNs into SDT is a topic of ongoing debate among researchers in  
41 motivational psychology (Vansteenkiste et al., 2020, 2023). As various new candidate needs  
42 have been proposed over the last decade, the criteria that BPNs should meet have been

1 reviewed and discussed among specialists in this theory (Ryan & Deci, 2017; Vansteenkiste  
2 et al., 2020, 2023). Ryan and Deci (2017) specified six criteria that were expanded to nine  
3 later (Vansteenkiste et al., 2020, 2023): 1) Essential; 2) Psychological; 3) Pervasive; 4)  
4 Universal; 5) Inherent; 6) Distinct; 7) Content-specific; 8) Directional; 9) Explanatory (for  
5 further information see Ryan & Deci, 2017; Vansteenkiste et al., 2020, 2023). Various studies  
6 conducted thus far have shown that novelty may fulfil some of these criteria (Bagheri &  
7 Milyavskaya, 2020; González-Cutre, Brugarolas-Navarro, et al., 2025; González-Cutre et  
8 al., 2016, 2020; Kosa & Uysal, 2024). However, other criteria (Vansteenkiste et al., 2020,  
9 2023) still require attention, as incorporating novelty as a new BPN represents a lengthy  
10 journey that has only just commenced (González-Cutre et al., 2016).

11 Novelty is defined as the need to experience something not previously experienced or that  
12 differs from everyday routine (González-Cutre et al., 2016). One of the main areas where  
13 studies on novelty have been developed is physical education. In the research conducted so  
14 far in this context, the relationships between novelty and different outcomes were in line  
15 with previous research on the three BPNs established in SDT. In this regard, novelty  
16 satisfaction was positively related to students' autonomous motivation (Fernández-Espínola  
17 et al., 2020; Fierro-Suero, Almagro, Sáenz-López, et al., 2020; González-Cutre & Sicilia,  
18 2019), vitality and flow (González-Cutre & Sicilia, 2019), emotions such as enjoyment and  
19 pride (Fierro-Suero, Almagro, & Sáenz-López, 2020; Fierro-Suero et al., 2024), and the  
20 intention to be physically active (Aibar et al., 2021). Conversely, novelty frustration has been  
21 associated with students' amotivation, lack of concentration, and boredom (González-Cutre,  
22 Brugarolas-Navarro, et al., 2025), among other consequences.

23 Although the outcomes arising from novelty satisfaction and frustration have received  
24 considerable attention in recent years, the impact of social factors on the novelty experience  
25 has not been examined to a similar degree. In this sense, it has been observed that physical  
26 education teachers' autonomy, competence, and relatedness support predicted students'  
27 novelty satisfaction (Aibar et al., 2021). However, little is currently known about the role  
28 that a novelty-supportive/thwarting teaching style plays in physical education in the eyes of  
29 students. A novelty-supportive style emerges when teachers propose activities that are  
30 unusual for students, introduce alternative content rather than the traditional one, use  
31 different materials, or implement innovative methodologies (Fierro-Suero, Almagro, Sáenz-  
32 López, et al., 2020). To our knowledge, only two studies have evaluated the effect of teacher  
33 novelty support and both were in a physical education context (Fierro-Suero, Almagro,  
34 Sáenz-López, et al., 2020; Fierro-Suero et al., 2024). However, none of these studies  
35 measured autonomy, competence, and relatedness support from the teacher. Accordingly, the  
36 interaction between novelty support and the other basic needs support could not be assessed.  
37 Therefore, the present study aimed to examine whether including the need for novelty within  
38 the full bright-side sequence of SDT improves the explanatory power of the model in  
39 physical education. From these previous works, it was concluded that teacher novelty  
40 support predicted not only novelty satisfaction (Fierro-Suero, Almagro, Sáenz-López, et al.,  
41 2020; Fierro-Suero et al., 2024), but also autonomy, competence, and relatedness satisfaction  
42 (Fierro-Suero, Almagro, Sáenz-López, et al., 2020). Furthermore, novelty support had a

1 direct effect on students' intrinsic motivation, as well as an indirect effect via BPN  
2 satisfaction and novelty satisfaction (Fierro-Suero, Almagro, Sáenz-López, et al., 2020).

3 Among the various outcomes linked to motivation for physical education, the intention to be  
4 physically active has been one of the most extensively examined (Vasconcellos et al., 2020),  
5 particularly in studies focused on the construct of novelty in physical education (e.g. Aibar  
6 et al., 2021; Fernández-Espínola et al., 2020; Fierro-Suero et al., 2024). This variable is  
7 understood as a proximal antecedent and a robust predictor of actual PA behavior (Ajzen,  
8 2020). For this reason, it was considered a central outcome in the present study to evaluate  
9 the potential impact of motivational processes fostered through need-supportive teaching.

10 Based on the criteria cited previously for establishing new BPNs and the research conducted  
11 thus far, it was deemed necessary to undertake the first study that included novelty in the full  
12 sequential model of the bright side of SDT (need support → need satisfaction → motivation  
13 → outcomes; Vasconcellos et al., 2020) together with the three BPNs. Therefore, this study  
14 aimed to examine the role of novelty support and novelty satisfaction in physical education.  
15 Specifically, it explored whether and how these variables help explain students' autonomous  
16 motivation and their intention to be physically active. To achieve this objective, two models  
17 were tested: a) a traditional model with the three classic BPNs, and b) an extended model  
18 that also included novelty support and novelty satisfaction. This comparison was intended  
19 to evaluate whether novelty shows core features of a candidate BPN—namely, (1) a content-  
20 based nature (i.e. whether novelty support relates to novelty satisfaction through students'  
21 novelty-related experiences, such as engaging in new activities), (2) a distinct role (i.e.  
22 whether novelty-related experiences and novelty satisfaction operate differently from, and  
23 add to, the three established needs), and (3) incremental explanatory value (i.e. whether  
24 adding novelty improves the model's ability to account for autonomous motivation and PA  
25 intention) (Vansteenkiste et al., 2023). In line with the SDT sequential model, we  
26 hypothesized that teachers' need support would positively predict students' need satisfaction  
27 with each type of support showing the strongest association with its corresponding need  
28 satisfaction (e.g. novelty support predicting novelty satisfaction). Need satisfaction would  
29 positively predict students' autonomous motivation, which in turn would positively predict  
30 their intention to be physically active (Figure 1).

31  
32 Figure 1

## 33 **Method**

### 34 *Participants*

35 The participants in this study were 888 secondary school students, 414 (46.62%) boys, 472  
36 (53.15%) girls, and 2 (0.23%) who preferred not to say, aged between 11 and 17 years ( $M =$   
37  $13.15$ ;  $SD = 1.17$ ). This age range was selected because it spans the full length of compulsory  
38 secondary education in Spain. The selection of participants was based on schools'  
39 willingness to participate in the study, resulting in a non-probabilistic sample. Five  
40 secondary schools (public and private) agreed to participate in the study; all were in the  
41 south-western region of Spain. The sample was distributed across the four grades of

1 mandatory secondary education as follows: 280 (31.53%) first graders, 327 (36.82%) second  
 2 graders, 222 (25%) third graders, and 59 (6.65%) fourth graders. A total of seven teachers  
 3 taught 40 classes. Physical education lessons were conducted twice a week, each session  
 4 lasting 60 minutes. The physical education curriculum, in accordance with Spanish  
 5 educational law, focused on teaching games and sports, corporeal expression, the  
 6 development of physical and motor skills, health and quality of life enhancement, and  
 7 physical activities in natural environments.

## 8 *Measures*

9 ***Basic psychological needs support.*** We used a scale composed of 12 items from the Support  
 10 for Basic Psychological Needs in Physical Education Questionnaire (Sánchez-Oliva et al.,  
 11 2013) and four items developed by Fierro-Suero, Almagro, Sáenz-López, et al. (2020) to  
 12 measure novelty support. Items are preceded by the stem “In my physical education class,  
 13 the teacher...” and measure autonomy support (e.g. “Often asks about the activities to be  
 14 carried out”), competence support (e.g. “Comes up with activities tailored to our skills”),  
 15 relatedness support (e.g. “Helps us to resolve conflicts amicably”), and novelty support (e.g.  
 16 “Often proposes new activities”). The responses to the items are given on a Likert-type scale  
 17 from 1 (*strongly disagree*) to 5 (*strongly agree*). In this research, the four-factor correlated  
 18 model obtained a good fit to the observed data:  $\chi^2 = 277.211$ ,  $df = 98$ ,  $p < .001$ ,  $\chi^2 / df =$   
 19  $2.829$ , CFI = .978, TLI = .974, SRMR = .027, RMSEA = .045 (90%CI = .039 – .052).

20 ***Basic psychological needs satisfaction.*** We used 12 items from the Spanish version of the  
 21 Basic Psychological Needs in Exercise Scale adapted to physical education (Moreno et al.,  
 22 2008; Vlachopoulos & Michailidou, 2006) and five items from the Novelty Need  
 23 Satisfaction Scale (González-Cutre & Sicilia, 2019; González-Cutre et al., 2016). The scale  
 24 begins with the stem “In my physical education class” and includes items to measure  
 25 autonomy satisfaction (e.g. “I have the opportunity to choose how to perform the exercises”),  
 26 competence satisfaction (e.g. “I feel that exercise is an activity in which I do very well”),  
 27 relatedness satisfaction (e.g. “I feel very comfortable with my classmates”), and novelty  
 28 satisfaction (e.g. “I frequently feel there are novelties for me”). Participants rated each item  
 29 on a five-point Likert scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). In this  
 30 research, the four-factor correlated model obtained a good fit to the observed data:  $\chi^2 =$   
 31  $358.128$ ,  $df = 98$ ,  $p < .001$ ,  $\chi^2 / df = 3.654$ , CFI = .976, TLI = .971, SRMR = .056, RMSEA  
 32 = .055 (90%CI = .049 – .060).

33 ***Autonomous motivation.*** To evaluate autonomous motivation, the Spanish adaptation  
 34 (Ferriz et al., 2015) of the Perceived Locus of Causality Scale (Goudas et al., 1994) was  
 35 employed. This instrument commences with the sentence “I take part in physical education”  
 36 and comprises 12 items divided into three subscales, each containing four items: intrinsic  
 37 regulation (e.g. “Because physical education is fun”), integrated regulation (e.g. “Because it  
 38 is in line with my way of life”), and identified regulation (e.g. “Because I want to learn sports  
 39 skills”). Responses are recorded on a 7-point Likert scale from 1 (*strongly disagree*) to 7  
 40 (*strongly agree*). Autonomous motivation was calculated by averaging the items from  
 41 intrinsic motivation, integrated regulation, and identified regulation. This operationalization

1 is consistent with SDT's motivation taxonomy, in which intrinsic, integrated, and identified  
2 regulations reflect more autonomous forms of motivation (Ryan & Deci, 2020). In this  
3 research, the one-factor model had a good fit to the observed data:  $\chi^2 = 242.673$ ,  $df = 54$ ,  $p$   
4  $< .001$ ,  $\chi^2 / df = 4.494$ , CFI = .983, TLI = .979, SRMR = .028, RMSEA = .064 (90%CI =  
5 .056 – .073).

6 ***Intention to be physically active.*** The intention to engage in PA was assessed using four  
7 items (e.g. "I would like to be physically active") from the Spanish version of the Intention  
8 to be Physically Active Scale (Hein et al., 2004; Moreno et al., 2007). Items were introduced  
9 with the stem "Regarding my intention to practice sport or PA in my free time". Participants  
10 responded to the items on a Likert-type scale ranging from 1 (*strongly disagree*) to 5  
11 (*strongly agree*). In this research, the four-item factor model had a good fit to the observed  
12 data:  $\chi^2 = 12.478$ ,  $df = 4$ ,  $p < .001$ ,  $\chi^2 / df = 3.120$ , CFI = .993, TLI = .982, SRMR = .018,  
13 RMSEA = .049 (90%CI = .020 – .080).

#### 14 *Procedure*

15 The study was conducted in line with the ethical guidelines of the American Psychological  
16 Association (2020) and received approval from the Andalusian Ethics Committee for  
17 Biomedical Research (TD-OCME-2018). Initially, the researchers reached out to school  
18 administrators and boards to inform them about the study and request their collaboration.  
19 Five secondary schools agreed to participate. As the participants were minors, written  
20 informed consent was obtained from their parents or legal guardians.

21 The data collection took place during school hours, and the questionnaires were administered  
22 in a classroom setting. A member of the research team was present to provide a brief  
23 explanation, ensure the smooth progression of the process, and answer any questions the  
24 students might have had. Participation was both anonymous and voluntary, and completing  
25 the questionnaire took approximately 25-30 minutes. To maintain data integrity, students  
26 who completed the questionnaire significantly faster than the average time were excluded  
27 from the analysis ( $n = 4$ ; 0.45% of the initial sample).

#### 28 *Data analysis*

29 As a preliminary step, confirmatory factor analyses were conducted to gather validity  
30 evidence based on the internal structure of each instrument used. Next, McDonald's omega  
31 coefficients were estimated with values above .70 as representative of good reliability. Latent  
32 correlations from the measurement model were also computed, with values as high as .85,  
33 indicating the absence of multicollinearity among variables (Kline, 2016). To ensure the  
34 trustworthiness of the results of the structural equation modelling (SEM) approach to be  
35 tested, a minimum sample size of 550 participants was estimated in accordance with  
36 Westland's (2010) recommendations. Before the two-step SEM, the intraclass correlation  
37 coefficient (ICC) was calculated to assess hierarchical structure within teachers delivering  
38 physical education lessons. ICC values above .10 indicate the need to account for the  
39 hierarchical nature of the data (Preacher et al., 2011). In such cases, and consistent with  
40 previous research (Santana-Monagas et al., 2024), the clustering of data at the teacher level

1 was controlled for by specifying “type=complex”. On the other hand, descriptive statistics,  
2 including means and standard deviations, were calculated.

3 To analyse the direct and indirect paths from students’ perceptions of teacher need support  
4 to their PA intention via need satisfaction and autonomous motivation, two models were  
5 tested. The first model included only three types of teachers’ need support and the  
6 satisfaction of the three BPNs, while the second model added teacher novelty support and  
7 students’ novelty satisfaction. Both models were performed using a two-step SEM approach  
8 (Kline, 2016). In the first step, the robustness of the measurement models (i.e. all target  
9 variables were freely correlated) was examined. In the second step, a predictive model was  
10 tested by examining the paths from teachers’ need support to PA intention via need  
11 satisfaction and autonomous motivation. They were estimated using the maximum  
12 likelihood robust (MLR) estimator because it gathers fit and standard error rates that are  
13 robust to non-normality and suitable for Likert scales with five or more response choices  
14 (Muthén & Muthén, 1998-2017). The goodness of the models’ fit was assessed using values  
15 of up to 3 for the coefficient between chi-squared and degrees of freedom ( $\chi^2/df$ ), greater  
16 than .95 for the Comparative Fit Index (CFI) and Tucker-Lewis Index (TLI), and as high as  
17 .060 for the Standardized Root Mean Square Residual (SRMR) and the Root Mean Square  
18 Error of Approximation (RMSEA) (Kline, 2016). In addition to direct paths ( $p \leq .05$ ),  
19 indirect paths were examined following Hayes’ (2021) recommendations, whereby an  
20 indirect (i.e. mediating) effect is considered significant when its 95% confidence interval  
21 (95% CI) does not contain zero. Students’ sex and age were included as covariates, in line  
22 with previous meta-analytic research (Vasconcellos et al., 2000) and given documented sex  
23 and age differences in the study variables (see Appendix). All analyses were run using  
24 Jamovi version 2.6.44 and Mplus version 8.0 (Muthén & Muthén, 1998-2017).

## 25 **Results**

### 26 *Preliminary analysis*

27 Table 1 shows that the average scores for each of the ten variables under study were higher  
28 than the midpoint of their respective measurement scales. McDonald’s omega scores were  
29 between .77 and .95, which gathered evidence for reliability. Moreover, latent correlations  
30 ranged from .26 to .85, indicating the absence of multicollinearity. More specifically, PA  
31 intention was positively correlated with all variables, showing the strongest correlation with  
32 competence satisfaction and autonomous motivation.

33 Table 1

### 34 *Multilevel structural equation modelling approach*

35 Prior to SEM, Table 1 reports ICC values ranging from .04 to .27, with 8 of the 10 variables  
36 exceeding .10. This indicated that students were clustered by teacher (i.e. students were  
37 taught by different physical education teachers), and, therefore, that the analyses needed to  
38 account for clustering at the teacher level.

39



1 In the first of the two steps of multilevel SEM, the robustness of the measurement model  
 2 was examined both for the model excluding novelty-related variables ( $\chi^2 = 2194.367$ ,  $df =$   
 3  $832$ ,  $\chi^2 / df = 2.703$ , CFI = .962, TLI = .958, SRMR = .057, RMSEA = .043, 90%CI = .041  
 4 – .045), and the model including the novelty-related variables ( $\chi^2 = 2809.461$ ,  $df = 1229$ ,  $\chi^2$   
 5  $/ df = 2.286$ , CFI = .966, TLI = .963, SRMR = .052, RMSEA = .037, 90%CI = .035 – .039).

6  
 7 In the second step of the multilevel SEM, the predictive structural model obtained an  
 8 acceptable fit to the observed data both for the model excluding novelty ( $\chi^2 = 2240.534$ ,  $df$   
 9  $= 829$ ,  $\chi^2 / df = 2.703$ , CFI = .960, TLI = .957, SRMR = .056, RMSEA = .044, 90%CI = .042  
 10 – .046), and the model including novelty ( $\chi^2 = 2837.108$ ,  $df = 1227$ ,  $\chi^2 / df = 2.312$ , CFI =  
 11 .965, TLI = .962, SRMR = .054, RMSEA = .038, 90%CI = .037 – .040). Overall, the  
 12 goodness-of-fit indexes slightly improved when novelty support and novelty satisfaction  
 13 were included. The standardized parameter estimates and the explained variances ( $R^2$ ) for  
 14 both models are shown in Figure 2.

15  
 16 Figure 2  
 17

18 In the model excluding novelty-related variables (see Figure 2a), each of the three types of  
 19 teachers' need support was most strongly associated with the satisfaction of its respective  
 20 need in students, with paths ranging from .31 (i.e. autonomy-support  $\rightarrow$  autonomy  
 21 satisfaction) to .84 (relatedness support  $\rightarrow$  relatedness satisfaction). However, there were  
 22 also cross-paths from teachers' competence and relatedness support to autonomy  
 23 satisfaction, as well as from competence support to relatedness satisfaction. Furthermore,  
 24 autonomy and competence satisfaction were positively associated with autonomous  
 25 motivation ( $\beta = .47$ ,  $p < .001$ ;  $\beta = .39$ ,  $p < .001$ ), while relatedness satisfaction was unrelated.  
 26 Autonomous motivation, in turn, was positively related to PA intention ( $\beta = .60$ ,  $p < .001$ ).  
 27 This model accounted for 48% of the explained variance in PA intention.

28 When the two novelty-related variables were included in the model (see Figure 2b), a similar  
 29 pattern emerged for the direct paths from teachers' need support to students' need  
 30 satisfaction. Teacher's novelty support was strongly associated with novelty satisfaction ( $\beta$   
 31  $= .89$ ,  $p < .001$ ) and was also related to autonomy satisfaction ( $\beta = .21$ ,  $p = .027$ ). The  
 32 inclusion of teachers' novelty support reduced the strength of the paths between teachers'  
 33 competence and relatedness support and autonomy satisfaction (from .64,  $p < .001$  to .40,  $p$   
 34  $< .001$  and from  $-.24$ ,  $p = .034$  to  $-.11$ ,  $p = .079$ , respectively). In addition, teacher  
 35 competence and relatedness support were positively related to novelty satisfaction ( $\beta = .25$ ,  
 36  $p = .009$ ;  $\beta = .20$ ,  $p = .035$ ). Following the motivational sequence, novelty satisfaction was  
 37 positively related to autonomous motivation ( $\beta = .39$ ,  $p < .001$ ), while the association  
 38 between competence satisfaction and autonomous motivation increased ( $\beta = .49$ ,  $p < .001$ ),  
 39 and the association between autonomy satisfaction and autonomous motivation became non-  
 40 significant ( $\beta = .08$ ,  $p = .612$ ). Akin to the previous model, relatedness satisfaction was  
 41 unrelated to autonomous motivation. Finally, autonomous motivation remained positively  
 42 associated with PA intention ( $\beta = .61$ ,  $p < .001$ ). With the inclusion of the two novelty-related

1 variables, the explained variance increased from 68% to 71% for autonomous motivation  
2 and from 48% to 53% for PA intention.

3 Table 2 shows the indirect effects of each type of teacher need support on PA intention  
4 through need satisfaction and autonomous motivation for both models.

5 Table 2

## 6 Discussion

7 The objective of this study was to incorporate the construct of novelty into the complete  
8 sequence of the bright side of SDT, analyzing the paths between teachers' need support for  
9 physical education and students' need satisfaction, autonomous motivation, and intention to  
10 be physically active. This is the first study to include novelty support and novelty satisfaction  
11 alongside the support and satisfaction of the three BPNs established by SDT (autonomy,  
12 competence, and relatedness). The findings support the idea that novelty, when  
13 conceptualized as a BPN (Bagheri & Milyavskaya, 2020; González-Cutre et al., 2016, 2020),  
14 contributes meaningfully to the explanation of motivational processes in physical education.  
15 Comparing the two models tested (with and without novelty constructs), the present study  
16 found that including teachers' novelty support and students' novelty satisfaction slightly  
17 increased the explained variances for students' need satisfaction (except for autonomy),  
18 autonomous motivation and PA intention. However, more importantly, the associations  
19 between the types of need support, need satisfaction, and autonomous motivation were  
20 modified, particularly the relationship between autonomy satisfaction and autonomous  
21 motivation, which showed reduced predictive strength. This reduction is consistent with  
22 previous research that included novelty in SDT-based models in physical education (Aibar  
23 et al., 2021; González-Cutre, Brugarolas-Navarro, et al., 2025; González-Cutre & Sicilia,  
24 2019; González-Cutre et al., 2016) and in other contexts (González-Cutre et al., 2020). These  
25 findings point out that if novelty was not included in the models, autonomy and competence  
26 could absorb the effect of this variable. This may prevent a complete understanding of  
27 students' motivation and the necessary strategies that teachers should implement to improve  
28 it. Novelty support and novelty satisfaction may reflect a motivationally relevant component  
29 that has not been explicitly modelled previously and has therefore been subsumed under  
30 other need-supportive behaviors and BPN satisfaction. The inclusion of novelty led to a  
31 redistribution of shared explained variance, allowing for a more precise understanding of the  
32 pathways linking teachers' instructional behaviors to students' autonomous motivation and  
33 related outcomes, and revealing meaningful modifications in the motivational sequence.  
34 When researchers and teachers think about autonomy- and competence-supportive practices,  
35 they may not routinely consider novelty-supportive practices. Given that novelty emerged  
36 as distinct from the three established needs and showed differential associations in the  
37 present study, incorporating novelty-support into SDT-informed practice could help further  
38 refine need-supportive processes in physical education.

39 Specifically, we found that novelty support positively predicted novelty and autonomy  
40 satisfaction. When teachers implement novel tasks, content, or teaching styles, use varied  
41 and innovative materials, conduct activities in different spaces, or explain content in creative

1 ways, students' novelty satisfaction is more likely to be fostered. Moreover, the inclusion of  
2 novelty support in an autonomy-supportive way could help to promote autonomy  
3 satisfaction. This would happen when students harmoniously internalize the novelties they  
4 receive from the environment. Therefore, applying novelty-supportive techniques  
5 (González-Cutre, Ferriz, & Jiménez-Loaisa, 2025) alongside support for the three BPNs  
6 (Ahmadi et al., 2023) could be advisable to trigger a positive motivational process in  
7 physical education.

8 Fierro-Suero, Almagro, Sáenz-López, et al. (2020) found the same results, although novelty  
9 support also positively predicted competence and relatedness satisfaction. Nevertheless, they  
10 did not include the support for the three BPNs in their model. When we estimated the full  
11 model simultaneously, including all four types of need support, we found a more  
12 parsimonious distribution of effects, with each type of need support showing its strongest  
13 association with the corresponding need satisfaction. This finding supports the idea that all  
14 BPNs should go hand in hand (Ryan & Deci, 2017).

15 Continuing with the analysis of the SDT sequential model, and focusing on the construct of  
16 novelty, we found that novelty satisfaction was also positively predicted by relatedness  
17 support and competence support. Similar results were reported by Aibar et al. (2021), but  
18 they did not include novelty support in their analysis and grouped the satisfaction of the three  
19 BPNs into a single latent variable. The present study extends previous research and explains  
20 68% of the variance in novelty satisfaction, compared to the 31% explained by Aibar et al.  
21 (2021). The opportunity to experience new and diverse social interactions in a relatedness-  
22 supportive context (Kristensen et al., 2025), together with the support for new learning  
23 opportunities through clear structure, goals and feedback (competence support), could also  
24 promote the students' satisfaction of their need for novelty in physical education.

25 Novelty satisfaction positively predicted students' autonomous motivation together with  
26 competence satisfaction. In line with a previous meta-analysis (Vasconcellos et al., 2020),  
27 the development of students' competence seems to be a key aspect to encourage positive  
28 motivation in physical education. However, novelty satisfaction stands out as the second  
29 predictor of autonomous motivation in the present study and past research (Fierro-Suero,  
30 Almagro, Sáenz-López, et al, 2020; González-Cutre & Sicilia, 2019; González-Cutre et al.,  
31 2016). One study even reported that, during the changes experienced in physical education  
32 classes due to the COVID-19 pandemic, novelty satisfaction showed a stronger association  
33 with autonomous motivation than the satisfaction of the three BPNs (Hsu et al., 2023). By  
34 contrast, another study highlighted autonomy satisfaction as a key predictor of autonomous  
35 motivation and suggested that it should be considered alongside competence and novelty  
36 satisfaction in physical education (Koka et al., 2021). Therefore, the consideration of the  
37 three BPNs along with the need for novelty seems fundamental to explain students'  
38 motivation in this context and to promote their intention to participate in extracurricular PA.

39 The results of this study, in addition to providing a motivational model of students' intention  
40 to be physically active, offered support for some of the less frequently addressed criteria  
41 (Vansteenkiste et al., 2023) for including novelty as a new BPN within SDT. The inclusion

1 of novelty support in the SDT sequential model tested in the present study showed that there  
2 are specific novelty-supportive behaviors and experiences that contribute to need satisfaction  
3 (novelty and autonomy satisfaction in this case), thereby reflecting the *content-based nature*  
4 of novelty. Novelty support showed the strongest association with novelty satisfaction, even  
5 after controlling for the other three types of teachers' need support. Moreover, these novelty-  
6 related experiences differed from those associated with autonomy, competence, and  
7 relatedness satisfaction, explaining additional variance in autonomous motivation beyond  
8 the three traditional needs and showing the *distinct role* of novelty. Finally, the present study  
9 demonstrated the *explanatory role* of novelty showing that variations in novelty-related  
10 features of the social context explained motivation and adaptive consequences in physical  
11 education. Overall model fit and explained variance improved when novelty was included.  
12 These findings reinforce the conceptual relevance of novelty within SDT and highlight its  
13 potential value for enhancing motivational strategies in physical education.

14 This study has several limitations that should be considered when interpreting the findings.  
15 First, the sample consisted exclusively of students from Spain, which may introduce cultural  
16 or contextual biases and limit the generalizability of the results to other educational or  
17 cultural settings. Second, the cross-sectional design precludes any causal conclusions  
18 regarding the relationships among the variables. Third, data were collected through self-  
19 report questionnaires, which may be subject to social desirability bias or individual  
20 interpretation. Finally, although all measurement instruments demonstrated acceptable  
21 psychometric properties, the inherent limitations of the scales used (such as the number of  
22 items or context-specific adaptation) should be acknowledged.

23 Future research should examine the longitudinal effects of novelty-supportive and novelty-  
24 thwarting environments on a range of positive and negative outcomes in physical education,  
25 to replicate and extend the present cross-sectional findings and to further explore the “dark  
26 side” of SDT. Likewise, to date, there is still a lack of person-centred research examining  
27 novelty in the same way that BPNs have been studied in recent years (e.g. Burgueño et al.,  
28 2023), which could help identify meaningful motivational profiles characterised by different  
29 combinations of novelty satisfaction and frustration and their links to adaptive and  
30 maladaptive outcomes. Furthermore, the implementation of novelty-supportive practices by  
31 the physical education teacher (see González-Cutre, Ferriz, & Jiménez-Loaisa, 2025) should  
32 be analyzed within school-based interventions to promote PA. In this regard, it would be  
33 helpful to compare the effects of motivational interventions that include strategies targeting  
34 traditional BPNs with those that explicitly incorporate novelty-supportive strategies, to  
35 better understand the additional contribution of novelty-focused approaches. Moreover,  
36 determining the “optimal dose” of novelty remains an important future goal; therefore,  
37 randomized controlled trials systematically testing different novelty-support strategies  
38 would be crucial for identifying their optimal intensity and combination (González-Cutre,  
39 2025). The exploration of novelty as a potential BPN should continue across various  
40 cultures, contexts, and life stages, building on past decade's research to determine whether it  
41 exhibits universal and inherent traits, as well as a proactive (growth-oriented) nature.

1 In conclusion, as far as we are aware, this study was the first that showed the significant role  
2 of novelty support and novelty satisfaction in the complete sequence of the bright side of  
3 SDT in physical education. Including these constructs in the model provided a more  
4 complete explanation of the relations between teachers' behaviors and students' motivational  
5 functioning. Teachers' novelty support positively predicted students' novelty and autonomy  
6 satisfaction. Novelty and competence satisfaction positively predicted students' autonomous  
7 motivation that in turn positively predicted their intention to be physically active. The present  
8 study also allowed us to explore further the inclusion criteria to consider novelty as a BPN.  
9 Although more research is needed on this topic, the evidence so far shows that novelty is a  
10 variable that should be considered from the SDT perspective.

11

### 12 **Declaration of conflicting interests**

13 The authors declared no potential conflicts of interest with respect to the research,  
14 authorship, and/or publication of this article.

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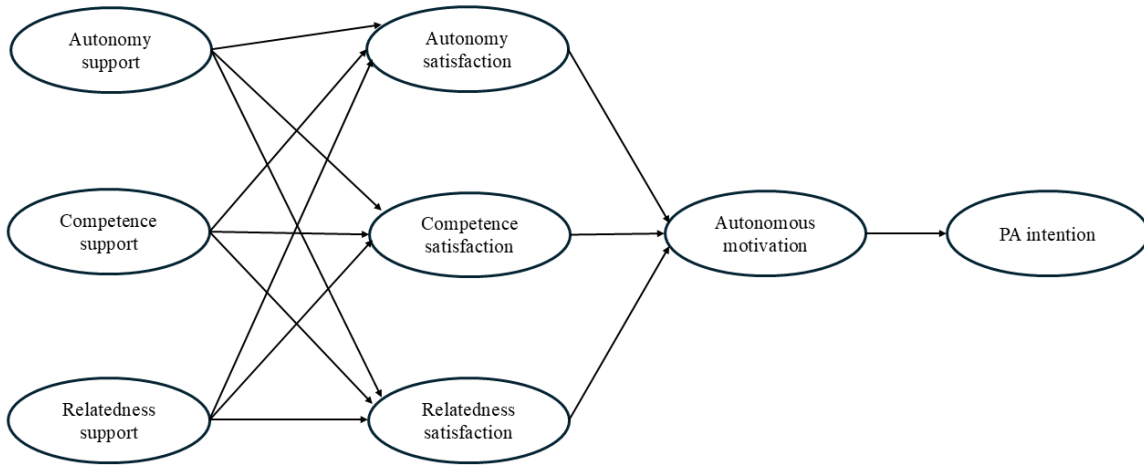
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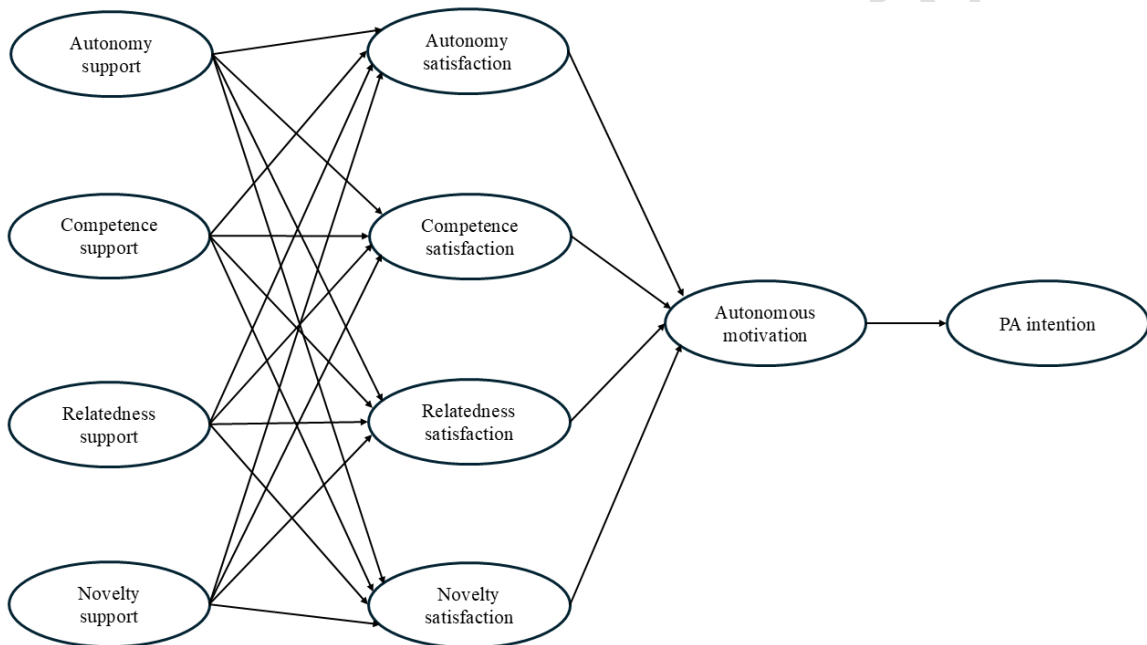
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29 novelty in a full sequential model of the bright side of self-determination theory in  
30 physical education. *European Physical Education Review*.  
31 <https://doi.org/10.1177/1356336X261434539>



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2 Figure 1a. Hypothesized model excluding novelty support from the teacher and students' novelty satisfaction.



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4 Figure 1b. Hypothesized model including novelty support from the teacher and students' novelty satisfaction.

5 Figure 1. Hypothesized relationships between teachers' need support, students' need satisfaction, autonomous  
6 motivation, and intention to be physically active.

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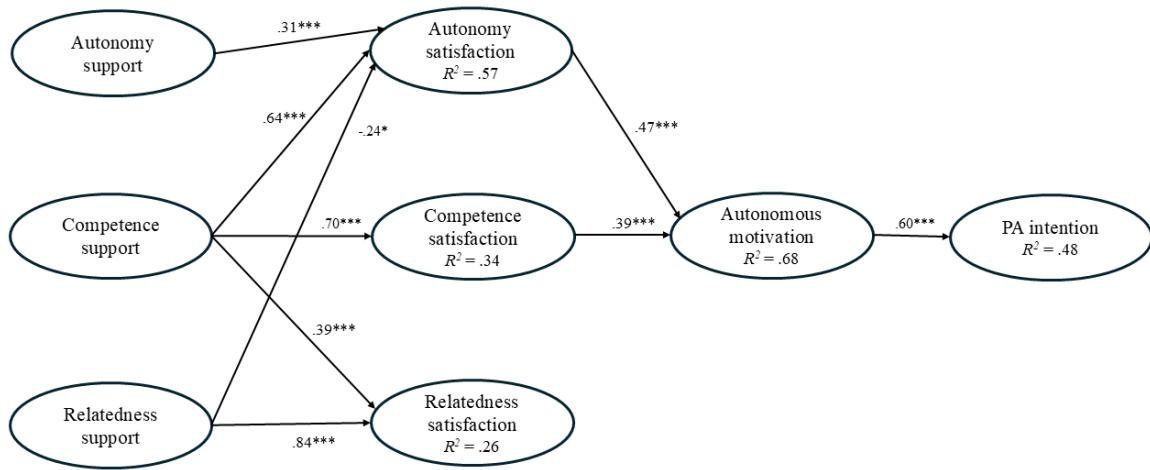
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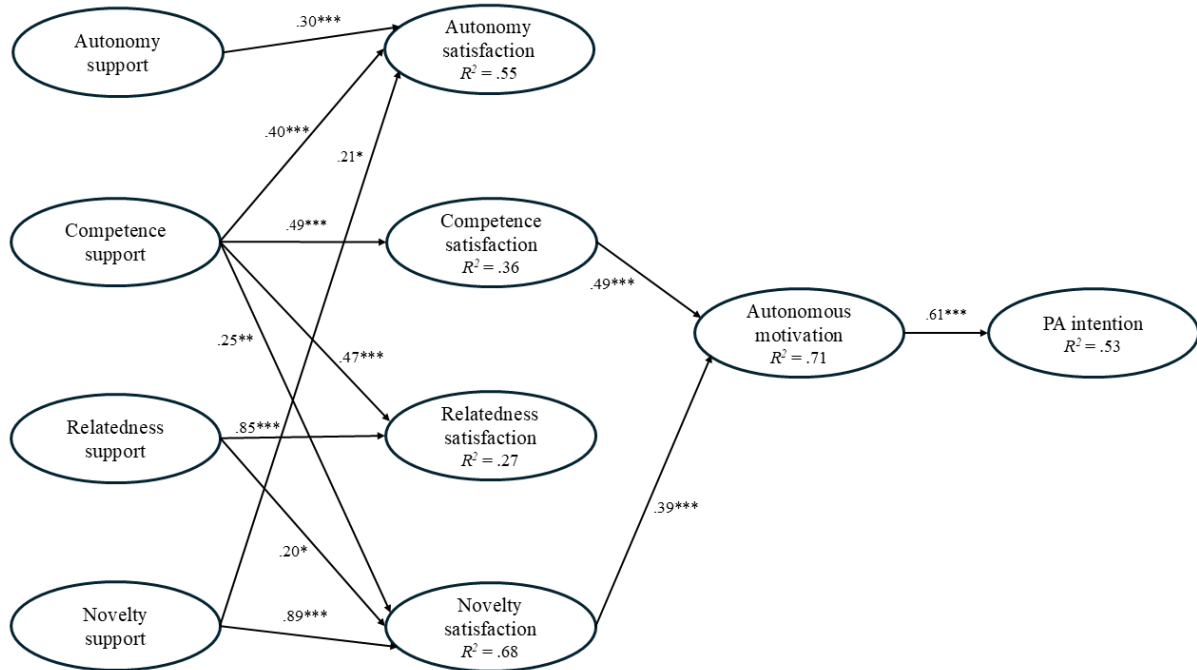
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Figure 2a. Model excluding novelty support from the teacher and students' novelty satisfaction.



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Figure 2b. Model including novelty support from the teacher and students' novelty satisfaction.

Figure 2. Structural equation modelling of students' perceptions of need support from the teacher, their need satisfaction, autonomous motivation, and intention to be physically active, considering the inclusion and exclusion of novelty-related variables. \*\*\* $p < .001$ , \*\* $p < .01$ , \* $p < .05$ .

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**Table 1.** Descriptive statistics, reliability coefficients, and latent correlations among study variables.

Variable	1	2	3	4	5	6	7	8	9	10
1. Autonomy Support	-									
2. Competence Support	.84	-								
3. Relatedness Support	.76	.81	-							
4. Novelty Support	.85	.80	.79	-						
5. Autonomy Satisfaction	.70	.69	.58	.70	-					
6. Competence Satisfaction	.39	.50	.45	.42	.71	-				
7. Relatedness Satisfaction	.28	.33	.47	.30	.42	.59	-			
8. Novelty Satisfaction	.66	.71	.58	.80	.83	.56	.46	-		
9. Autonomous Motivation	.54	.69	.57	.64	.74	.75	.47	.71	-	
10. PA Intention	.26	.37	.34	.33	.51	.74	.39	.40	.73	-
Range	1-5	1-5	1-5	1-5	1-5	1-5	1-5	1-5	1-7	1-5
Mean	3.04	3.92	4.02	3.51	3.02	3.78	4.19	3.48	5.32	4.18
Standard Deviation	1.04	.95	.94	1.06	.92	.88	.87	.92	1.33	.83
Coefficient $\omega$	.83	.82	.86	.86	.79	.80	.84	.86	.95	.77
ICC	.22	.23	.23	.27	.10	.05	.10	.14	.11	.04

Note: All the correlations were significant ( $p < .001$ ). PA = Physical activity. ICC = Intraclass correlation coefficient.



1 **Table 2.** Standardized indirect effects from need support to PA intention through need satisfaction and  
 2 autonomous motivation

	Model without novelty	Model with novelty
	$\beta$ (95%CI)	$\beta$ (95%CI)
Indirect effect of teachers' autonomy support on PA intention		
Total indirect effects	.051 (-.066; .169)	-.057 (-.198; .084)
Specific indirect via autonomy satisfaction and autonomous motivation	.093 (.019; .167)	.014 (-.037; .066)
Specific indirect via competence satisfaction and autonomous motivation	-.040 (-.086; .006)	-.034 (-.097; .030)
Specific indirect via relatedness satisfaction and autonomous motivation	-.001 (-.008; .006)	.002 (-.001; .004)
Specific indirect via novelty satisfaction and autonomous motivation	–	-.039 (-.131; .052)
Indirect effect of teachers' competence support on PA intention		
Total indirect effects	.355 (.179; .531)	.320 (.082; .558)
Specific indirect via autonomy satisfaction and autonomous motivation	.191 (.110; .271)	.019 (-.062; .100)
Specific indirect via competence satisfaction and autonomous motivation	.175 (.059; .291)	.232 (.026; .438)
Specific indirect via relatedness satisfaction and autonomous motivation	-.011 (-.027; .005)	.009 (-.015; .034)
Specific indirect via novelty satisfaction and autonomous motivation	–	.059 (-.029; .148)
Indirect effect of teachers' relatedness support on PA intention		
Total indirect effects	-.046 (-.205; .113)	-.083 (-.246; .080)
Specific indirect via autonomy satisfaction and autonomous motivation	-.060 (-.104; -.016)	-.008 (-.038; .022)
Specific indirect via competence satisfaction and autonomous motivation	-.010 (-.110; .091)	.009 (-.131; .113)
Specific indirect via relatedness satisfaction and autonomous motivation	.023 (-.028; .075)	-.017 (-.050; .016)
Specific indirect via novelty satisfaction and autonomous motivation	–	-.049 (-.103; .005)
Indirect effect of teachers' novelty support on PA intention		
Total indirect effects	–	.259 (.077; .380)
Specific indirect via autonomy satisfaction and autonomous motivation	–	.010 (-.031; .052)
Specific indirect via competence satisfaction and autonomous motivation	–	.039 (-.182; .104)
Specific indirect via relatedness satisfaction and autonomous motivation	–	-.002 (-.010; .006)
Specific indirect via novelty satisfaction and autonomous motivation	–	.210 (.050; .370)

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17 **Appendix**

## 18 Sex and age differences for the variables under study

	Male	Female	Sex differences			Younger (11-13)	Older (14-17)	Age differences		
	M(SD)	M(SD)	F(1)	p-value	$\eta^2$	M(SD)	M(SD)	F(1)	p-value	$\eta^2$
Autonomy support	3.09(1.04)	2.99 (1.03)	2.25	.134	<.01	2.96(1.00)	3.08(1.06)	2.81	.094	<.01
Competence support	3.99(0.89)	3.87(0.99)	3.80	.050	.01	3.79(0.93)	4.00(0.95)	9.43	.002	.01
Relatedness support	4.06(0.90)	3.98(0.97)	1.84	.172	<.01	3.94(0.90)	4.60(0.96)	3.72	.050	.01
Novelty support	3.57(1.06)	3.47(1.06)	2.12	.146	<.01	3.39(1.10)	3.59(1.02)	7.36	.007	.01
Autonomy satisfaction	3.14(0.88)	2.92(0.94)	12.15	<.001	.02	2.94(0.90)	3.07(0.93)	3.58	.059	<.01
Competence satisfaction	3.99(0.78)	3.59(0.92)	45.84	<.001	.05	3.71(0.88)	3.82(0.88)	3.23	.073	<.01
Relatedness satisfaction	4.28(0.77)	4.11(0.94)	7.76	.005	.01	4.10(0.94)	4.25(0.82)	6.32	.012	.01
Novelty satisfaction	3.53(0.90)	3.45(0.94)	1.81	.178	<.01	3.38(0.93)	3.55(0.91)	6.99	.008	.01
Autonomous motivation	5.54(1.23)	5.12(1.38)	21.98	<.001	.02	5.13(1.36)	5.42(1.30)	9.95	.002	.01
PA intention	4.35(0.75)	4.02(0.87)	35.34	<.001	.04	4.19(0.82)	4.16(0.85)	0.25	.616	.00

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