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**Understanding students' novelty satisfaction in physical education: Associations
with need-supportive teaching style and physical activity intention**

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Abstract

Novelty satisfaction has recently been associated with positive outcomes in physical education (PE) lessons. Grounded in self-determination theory, this study aimed to examine the relationships between need-supportive teaching behaviours in PE and students' satisfaction of basic psychological needs (BPNs), novelty satisfaction, and intention to be physically active. From a final sample of 1118 students (49.1% boys; 50.9% girls; $M=14.11\pm 1.50$ years), the adolescents' perception of need-support from PE teachers, BPN satisfaction, novelty satisfaction, and intention to be physically active were measured through different validated questionnaires. Results from structural equation modelling showed that students' perceptions of autonomy, competence, and relatedness support from PE teachers positively predicted BPN and novelty satisfaction. Furthermore, BPN and novelty satisfaction positively predicted intention to be physically active. Our results seem to support that need-supportive environments could be directly associated with novelty satisfaction. Likewise, novelty satisfaction seems to have an additional role in explaining intention to be physically active. These findings suggest the importance of designing need-supportive strategies in PE lessons to satisfy not only BPNs but also novelty, which can help to develop an active lifestyle among adolescents. Nevertheless, future research should also develop specific strategies aimed at supporting students' novelty in PE lessons.

Keywords: self-determination theory, basic psychological needs, physical activity, novelty, motivating teaching style, adolescents.

Introduction

Despite the well-known benefits of physical activity (PA), it is acknowledged worldwide that more than three-quarters of adolescents are not sufficiently physically active (Aubert et al., 2018; Guthold et al., 2020). Although a large number of promising strategies to promote PA have been recently identified (Messing et al., 2019), it seems that the World Health Organization 2025 Global PA target (i.e. 10% relative reduction in prevalence of insufficient PA) will not be met (Guthold et al., 2018). Throughout the last three decades, research has focused on understanding which factors influence PA behaviour, to design school-based PA interventions for target populations (Bauman et al., 2012). Although there are multiple factors that affect PA behaviour (Bauman et al., 2012), adolescents' motivational experiences in physical education (PE) have been identified as an important determinant in the school setting (Curran and Standage, 2017; Sun et al., 2017; Van den Berghe et al., 2014). Therefore, schools and, particularly, PE are ideal settings to directly provide adolescents with multiple opportunities to meet PA guidelines (Hollis et al., 2017) as well as to indirectly empower them to be physically active in their daily lives (González-Cutre et al., 2014; Slingerland and Borghouts, 2011). Providing students with positive motivational experiences during PE lessons could increase their PA engagement outside school (Hagger and Chatzisarantis, 2016). Of the different psychological theories of motivation and behaviour change, self-determination theory (SDT) is considered to be one of the most effective theoretical approaches to develop school-based PA interventions within a PE context (Ntoumanis et al., 2018).

SDT and the need for novelty

SDT is a motivational framework that has focused on exploring the main antecedents and individual factors of different human experiences, such as PA participation (Ryan

and Deci, 2017). This theory proposes that people have three innate and universal basic psychological needs (BPNs) (i.e. autonomy, competence, and relatedness), which must be satisfied by the social environment to promote well-being and different growth manifestations such as intrinsic motivation and internalization (Vansteenkiste and Ryan, 2013). Ryan and Deci (2000) postulate that to fulfil the autonomy, competence, and relatedness needs, people must satisfy the desire for choice and volition over their activities and goals, experience a sense of efficacy, and a sense of connectedness with significant others, respectively. For example, in PE lessons, students may feel that they have the opportunity to choose between different activities and have diverse responsibilities in terms of their learning process (i.e. autonomy satisfaction). They may also feel confident to perform the different tasks proposed by the teacher (i.e. competence satisfaction), as well as connected and integrated with significant others (i.e. relatedness satisfaction). Alongside these BPNs, recent studies grounded in the SDT framework (Bagheri and Milyavskaya, 2020; González-Cutre et al., 2020; González-Cutre et al., 2016; Vansteenkiste et al., 2020), have discussed the possibility of considering novelty as a possible additional fourth BPN.

Novelty can be defined as the need to experience something not previously experienced or excluded from daily routine (González-Cutre et al., 2016). Satisfying novelty may be important within PA settings, as it represents a possible mechanism to increase not only autonomous motivation in PE but also other positive outcomes such as well-being, vitality, flow, enjoyment, and even satisfaction with exercise (González-Cutre et al., 2020; González-Cutre and Sicilia, 2019; González-Cutre et al., 2016; Sylvester et al., 2018). Considering novelty as a construct that is independent of the three BPNs, and given that novelty satisfaction is related to positive outcomes in different contexts such as physical exercise and general life (González-Cutre et al.,

2020; González-Cutre et al., 2016), further study of novelty satisfaction as a central element of interest in the PE context is warranted. The introduction of novelty in different facets of PE could help to increase students' interest and curiosity and, consequently, their involvement in the learning process (González-Cutre et al., 2016). Nevertheless, taking into account that the study of novelty within the SDT framework is quite recent, and scarce in PE settings (Fernández-Espínola et al., 2020a; González-Cutre and Sicilia, 2019; González-Cutre et al., 2016), it seems necessary to consider previous research evidence regarding BPNs to better understand the hypothetical mechanisms of novelty satisfaction. For instance, given that a large body of evidence in the context of PE has shown that BPN satisfaction is positively related to different antecedents and outcomes (Sun et al., 2017), studying the relationship between need-supportive teaching style and novelty satisfaction (Fierro-Suero et al., 2020; Sevil-Serrano et al., 2020), as well as its subsequent relationship with PA-related outcomes (Fernández-Espínola et al., 2020b), such as intention to be physically active, becomes an important contribution to literature.

BPN and novelty satisfaction in PE: relationship with PA-related outcomes

In the PE setting, satisfying BPNs has been positively associated with positive outcomes such as PA or intention to be physically active among adolescents (Chen et al., 2020; Di Battista et al., 2018; Taylor et al., 2010). This positive association with adolescents' PA-related outcomes in the PE context has also been shown through the mediation of autonomous types of motivation (Sánchez-Oliva et al., 2014; Sicilia et al., 2016). Of the three BPNs, literature in different domains, such as PE and leisure-time PA, shows how competence need satisfaction is the strongest positive predictor of PA in comparison to the other two BPNs (i.e. autonomy and relatedness) (Sicilia et al., 2016; Taylor et al., 2010; Teixeira et al., 2012).

Considering previous research on the need for novelty, we expected novelty satisfaction to also behave in a similar way to satisfaction of the three BPNs in terms of explaining PA participation. Taking into account former positive associations of novelty satisfaction with intrinsic motivation (González-Cutre et al., 2016), and positive outcomes such as vitality, dispositional flow, and satisfaction in PE lessons (González-Cutre and Sicilia, 2019), we could reasonably expect novelty satisfaction to be positively associated with intention to be physically active. In fact, two recent studies conducted among adolescents showed that novelty satisfaction in PE was positively related to intention to be physically active through the mediation of autonomous motivation (Fernández-Espínola et al., 2020a, 2020b). To our knowledge, no studies to date have directly examined the relationship of novelty satisfaction in PE, together with satisfaction of the three BPNs, with one of the key determinants of PA behaviour, such as intention to be physically active (Rhodes et al., 2017). Further studies are required to understand the role played by novelty satisfaction in PE in PA intention in order to create more need-supportive environments that foster students' novelty satisfaction.

Need-supportive teaching behaviours in PE

To satisfy students' BPNs and, consequently, promote positive outcomes in a school-based PE setting, it is essential to consider the students' experiences and perceptions of need-supportive behaviours during PE lessons (Liu et al., 2017). According to SDT, a need-supportive environment is comprised of autonomy, competence, and relatedness support. Research has shown that a need-supportive environment developed by the PE teacher is positively related to students' BPN satisfaction (Rutten et al., 2012; Standage et al., 2005; Vasconcellos et al., 2019; Zhang et al., 2011). However, most studies have only focused on the role of autonomy support in BPN satisfaction, not considering competence or relatedness support (Behzadnia et al., 2018; Ulstad et al., 2018;

Vasconcellos et al., 2019). Further studies are needed to examine the role of each source of support in students' BPN satisfaction in order to design teachers' motivational strategies in PE.

Moreover, to our knowledge, only two studies to date have examined the relationship between a need-supportive environment and novelty satisfaction in PE. However, results should be interpreted with caution as these relationships were exclusively examined via correlation analysis (Fierro-Suero et al, 2020; Sevil-Serrano et al., 2020). Given that in a need-supportive environment (i.e. autonomy, competence, and relatedness support) students probably feel that they frequently discover and create new situations, a positive relationship with novelty satisfaction in PE cannot be neglected (González-Cutre and Sicilia, 2019). First, autonomy support from PE teachers could influence novelty satisfaction by involving students in decision-making in terms of new elements from their teaching-learning process (e.g. new content, activities, materials, technology, methodologies, etc.). Second, competence support from PE teachers may promote a balance between competence and novelty satisfaction in new activities by providing optimal challenges, realistic goals, and positive and interrogative feedback. Third, relatedness support from PE teachers could influence novelty satisfaction by creating new, warm, and friendly relationships between students in different cooperative activities. For instance, promoting perceived variety in the composition of cooperative learning groups could also influence relatedness satisfaction. This study seeks to fill this gap in literature by examining the direct role of autonomy, competence, and relatedness support from PE teachers in students' novelty satisfaction in PE.

The present study

Research about the role of novelty as an important element in motivational models together with the three BPNs is in its infancy, with few studies in PE settings thus far (González-Cutre and Sicilia, 2019; González-Cutre et al., 2016). For instance, little is known about the relationship of novelty satisfaction in PE with some PA-related outcomes such as PA intentions or antecedents such as need-supportive PE teaching behaviours. To fill this research gap, and based on the SDT framework, the aims of this study were: a) to analyse the relationships between a need-supportive environment in PE and BPN and novelty satisfaction; b) to test the relationships between BPN and novelty satisfaction, and intention to be physically active. According to previous literature, a theoretical model was hypothesised to analyse all these relationships (see Figure 1). Consistent with previous studies (Hagger et al., 2006), and given that satisfaction of all three needs is required for optimal functioning, a higher-order BPN satisfaction construct was calculated in this study.

<INSERT FIGURE 1 ABOUT HERE, PLEASE>

Considering the first aim, and based on previous studies (Rutten et al., 2015; Standage et al., 2005; Vasconcellos et al., 2019; Zhang et al., 2011), need-supportive PE teaching behaviours were expected to be positively related to students' satisfaction of the three BPNs. Consequently, and considering a similar functioning between novelty and the three BPNs (González-Cutre et al., 2016), as well as the positive correlation results found in recent studies (Fierro-Suero et al., 2020; Sevil-Serrano et al., 2020), it was also hypothesised that a need-supportive environment could be positively associated with students' novelty satisfaction.

With respect to the second aim, and according to previous studies (Di Battista et al., 2018; Gunnell et al., 2016; Taylor et al., 2010), it was initially hypothesised that students' BPN satisfaction in PE would be positively related to intention to be physically active. Regarding novelty, and considering studies that have analysed other conceptually related variables such as perceived variety (Bagheri and Milyavskaya, 2020), which has previously shown a positive relationship with leisure-time PA (Sylvester et al., 2018), it was also hypothesised that novelty satisfaction would behave similarly. In fact, a positive prediction of novelty satisfaction in PE on intention to be physically active through the mediation of autonomous motivation has also been recently reported (Fernández-Espínola et al., 2020a, 2020b).

Methods

Participants and procedure

The initial sample of this study consisted of 1153 students from four secondary schools in Huesca (Spain). Participation was entirely voluntary and confidential. After obtaining written informed consent from parents and adolescents, students completed a paper-and-pencil survey in a quiet classroom setting. After removing invalid data (97% valid response rate), the final sample was composed of 1118 secondary school students (49.1% boys, 50.09% girls; $M=14.11\pm 1.50$ years old) who answered the questionnaires. Specifically, answers regarding teachers' need-supportive behaviours were given for nine different PE teachers. This study was approved by the Ethics Committee for Clinical Research of Aragón (Spain).

Instruments

Teachers' need-supportive behaviours. Students' perceptions of autonomy, competence, and relatedness support from PE teachers were assessed by the Spanish version of the Questionnaire of Basic Psychological Needs Support in Physical Education (Sánchez-Oliva et al., 2013). The statement “In PE classes, my teacher...” was followed by 12 items (four items per factor) that assessed: autonomy support (e.g. “Takes into account our opinion in the development of the lessons”), competence support (e.g. “Encourages us to trust our ability to correctly do the tasks”), and relatedness support (e.g. “Encourages positive interactions among all class students”). Participants reported their level of agreement using a five-point Likert scale from 1 (strongly disagree) to 5 (strongly agree).

Basic psychological need satisfaction in PE. Students' perceptions of the three BPN satisfaction (i.e. autonomy, competence, and relatedness) were assessed using the Spanish version in PE (Moreno et al., 2008) of the Basic Psychological Needs in Exercise Scale (BPNES; Vlachopoulos and Michailidou, 2006). The statement “In PE classes...” was followed by 12 items (four items per BPN) that assessed: autonomy satisfaction (e.g. “I feel that the way I do PE is definitely an expression of myself”), competence satisfaction (e.g. “I feel that PE is an activity in which I do very well”), and relatedness satisfaction (e.g. “I feel there are open channels of communication with my classmates”). Participants reported their level of agreement using a five-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree).

Novelty satisfaction in PE. Students' perceptions of novelty satisfaction in PE were assessed using the Spanish version of the Novelty Need Satisfaction Scale (NNSS; González-Cutre and Sicilia, 2019; González-Cutre et al., 2016). This scale was slightly adjusted to the PE setting by using the statement, “When I do PE...”, at the beginning

of the five items (e.g. “When I do PE, I feel I do novel things”). Participants reported their level of agreement using a five-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree).

Intention to be physically active. Students' intention to be physically active was assessed using three items (e.g. “I intend to do active sports and/or physical activities during my leisure-time in the next 5 weeks...”) of the Theory of Planned Behaviour Questionnaire (Hagger et al., 2009). This scale is rated on a seven-point Likert scale ranging from 1 (strongly agree) to 7 (strongly disagree).

Data analysis

All analyses of this study were carried out using the statistical programs SPSS v.20 and Mplus v7.4. Prior to performing the main analyses, confirmatory factor analysis (CFA) of the study variables was performed. With regard to autonomy, competence, and relatedness satisfaction, a final second-order CFA model (the three need satisfaction constructs as the first-order factors, and a composite construct for need satisfaction as a second-order factor) was conducted. Due to both parsimony and theoretical reasons, the following analyses were performed based on the second-order model of BPN satisfaction proposed in Figure 1.

Subsequently, descriptive statistics (means and standard deviations) were calculated. The scale score reliability estimates were computed using the following three parameters. First, composite reliability was calculated using McDonald's (1970) omega coefficient [$\omega = (\sum |\lambda_i|)^2 / ((\sum |\lambda_i|)^2 + \sum \delta_{ii})$], in which the standardised factor loadings are λ_i and the standardised item uniquenesses are δ_{ii} . Omega coefficient (ω), compared to traditional scale score reliability parameters (i.e. Cronbach's alpha), considers the strength of association between items and constructs (λ_i), as well as item-specific measurement errors (δ_{ii}) (Dunn et al., 2014). Second, average variance extracted (AVE);

Fornell and Larcker, 1981) was calculated. The AVE considers the amount of variance that is captured by the construct in relation to the amount of variance caused by the measurement error. AVE values below .50 do not support the convergent validity of the factor. Third and finally, given that Cronbach's alpha has traditionally been used to assess internal consistency reliability, this coefficient was also calculated.

Latent correlations, CFA, and structural equation modelling (SEM) were performed via maximum likelihood estimator (ML), which considers the non-normality distribution of the data, and is considered to be more appropriate for Likert scales (Beauducel and Herzberg, 2006). Latent correlations were independently calculated for autonomy, competence, and relatedness satisfaction. Three model fit indices were used to define good models: the Root Mean Square Error of Approximation (RMSEA) with its 90% confidence interval, the Comparative Fit Index (CFI), and Tucker-Lewis Index (TLI). According to typical interpretation guidelines (Marsh et al., 2004), RMSEA values below .08 and .06 indicate adequate and excellent fit indices, respectively. CFI and TLI values above .90 and .95 are also considered as adequate and excellent indices, respectively (Marsh et al., 2004). In addition, in the SEM model, the 95% bias-corrected bootstrap confidence intervals (95% CI_{BC}) were calculated for each of the proposed pathways with 5000 bootstrap samples (Hayes and Scharkow, 2013). Finally, the standardised regression weights (α , β), specific indirect effects ($\alpha\beta$), sum of indirect effects, and explained variance (R^2) were reported. However, it is important to note that two alternative models were previously tested and compared with the retained model proposed in Figure 1. First, a model without the novelty satisfaction items was examined to consider the appropriateness of including novelty satisfaction in the proposed model. Next, an additional second model including BPN and novelty satisfaction in a single latent common variable was examined to test the possibility of

analysing novelty as a separate variable. Akaike information criterion (AIC) and Bayesian information criterion (BIC) values were used to compare these models.

Results

Preliminary findings

Prior to conducting the main analyses, CFA models of the independent variables included in the predictive model were conducted. Both the three-factor CFA model of autonomous, competence, and relatedness support ($\chi^2=211.431$, $p<.001$; $\chi^2/df=4.14$; RMSEA=.056; 90% CI=.048-.064; CFI=.972; TLI=.961) and the one-factor CFA model for novelty satisfaction ($\chi^2=12.663$, $p<.001$; $\chi^2/df=2.53$; RMSEA=.044; 90% CI=.018-.072; CFI=.996; TLI=.989) showed adequate goodness-of-fit. With regard to BPN satisfaction, considering the large positive and significant associations between the three BPN latent variables ($r_{\text{autonomy-competence}} = .79$, $p<.001$; $r_{\text{autonomy-relatedness}} = .62$, $p<.001$; $r_{\text{competence-relatedness}} = .74$, $p<.001$), apart from theoretical reasons, analyses were performed based on a second-order model for parsimony reasons. In support of this agreement, autonomy ($r=.85$, $p<.001$), competence ($r=.86$, $p<.001$), and relatedness satisfaction ($r=.79$, $p<.001$) were also highly positively correlated with the composite score of BPN satisfaction. The second-order CFA model for BPN satisfaction also revealed adequate goodness-of-fit ($\chi^2=131.698$, $p<.001$; $\chi^2/df=2.58$; RMSEA=.039; 90% CI=.032-.048; CFI=.982; TLI=.975).

Descriptive and predictive findings

Descriptive statistics, scale score reliability estimates (i.e. Omega coefficient, AVE, and Cronbach's alpha), and latent correlations for all study variables are reported in Table 1. It should be highlighted that latent correlations among all study variables showed significant ($p<.001$), positive, and medium-to-large (i.e. $r=.27$ to $.79$) associations.

<INSERT TABLE 1 ABOUT HERE, PLEASE>

Prior to conducting the predictive model, a measurement model, in which all variables were allowed to correlate freely, was tested ($\chi^2=2048.181, p<.001; \chi^2/df=4.64; RMSEA=.057; 90\% CI=.055-.060; CFI=.948; TLI=.942$). Subsequently, the theory-based model, including indirect paths from autonomy, competence, and relatedness support, through BPN and novelty satisfaction, toward intention to be physically active, was estimated, showing good fit to the data (see Table 2). Associations between autonomy, competence, and relatedness support and BPN and novelty satisfaction, and between these variables and intention to be physically active, are represented respectively by α and β in Table 3, and are shown graphically in Figure 2. Students' perceptions of autonomy, competence, and relatedness support from PE teachers were significantly and positively related to BPN ($\alpha =.25$ to $.36$) and novelty ($\alpha =.15$ to $.29$) satisfaction. Furthermore, BPN and novelty satisfaction were also significantly and positively related to intention to be physically active ($\beta=.37$ and $\beta=.14$, respectively). The independent variables of that model (i.e. autonomy, competence, and relatedness support) were positively correlated among them (i.e. $r_{\text{autonomy-competence support}} = .79, p<.001; r_{\text{autonomy-relatedness support}} = .70, p<.001; r_{\text{competence-relatedness support}} = .80, p<.001$). The specific indirect effects ($\alpha\beta$) and their bias-corrected bootstrap confidence intervals are also presented in Table 3. Overall, both BPN and novelty satisfaction showed significant specific indirect effects from autonomy, competence, and relatedness support to intention to be physically active, although these effects were stronger for BPN satisfaction. The sum of all indirect effects was positive (from $.13$ to $.15$) and significant.

<INSERT TABLE 2 AND 3 AND FIGURE 2 ABOUT HERE, PLEASE>

To ensure the appropriateness of the proposed model, two other alternative models were tested. The first alternative model (see supplementary material 1), which did not include novelty satisfaction, showed good fit to the data (see Table 2), and explained 22% of variance in intention to be physically active. However, the proposed model (i.e. Figure 1) explained slightly more variance (i.e. >2%) than the model without novelty (first alternative model). While this little increase in variance could be due to a natural result of adding one more significant variable (i.e. novelty satisfaction) in the proposed model, and comparison with AIC and BIC values is not possible as the number of items in both models is different, the rest of statistical parameters offered support to choose the proposed model (i.e. with novelty satisfaction) instead of the first alternative model (i.e. without novelty satisfaction) (Marsh et al., 2004). More precisely, as observed in Table 2, the theory-based model, compared to the first alternative model, showed lower values of RMSEA, and higher values of CFI and TLI. Similarly, the second alternative model (see supplementary material 2), which was comprised of a common latent variable (BPN plus novelty satisfaction) also showed good fit to the data (see Table 2). In this model, the explained variance was exactly the same as in the original model (i.e. 24%, see Figure 1). Nevertheless, the original model showed slightly better AIC and BIC values. These analyses reinforce the pertinence of the proposed model, which permits analysing the separate effect of novelty satisfaction from BPN satisfaction.

Discussion

Grounded in SDT, the purpose of this study was to explore the relationships between need-supportive teaching behaviours, BPN and novelty satisfaction, and intention to be physically active. The main findings of the study revealed: 1) the positive relationship between perceptions of autonomy, competence, and relatedness support from PE teachers and novelty satisfaction, and 2) the positive relationship between novelty satisfaction in PE and intention to be physically active outside school. These results seem to suggest that novelty satisfaction may behave in the same way as the three BPNs in a PE setting, regarding some antecedents and outcomes tested from the SDT perspective.

With respect to the first objective of this study, students' perception of autonomy, relatedness, and particularly competence support from PE teachers had a significantly positive effect on BPN satisfaction. This result is consistent with previous studies (Rutten et al., 2012; Standage et al., 2005; Vasconcellos et al., 2019; Zhang et al., 2011), which have already shown how need-supportive environments in PE are positively related to students' BPN satisfaction. Competence support from PE teachers could be the most strongly related to BPN satisfaction because some strategies, such as providing positive, individual and interrogative feedback, different activity levels, and sufficient time to learn, are closely related to all three BPNs (Van den Berghe et al., 2014; Vasconcellos et al., 2019).

Our findings contribute to the literature by showing how the three BPN supports may have a positive association with novelty satisfaction in a PE setting, particularly student perceptions of teacher autonomy support. These results are in line with the two existing studies showing that competence, relatedness, and particularly autonomy support from PE teachers were positively related to novelty satisfaction in PE via correlation analysis (Fierro-Suero et al., 2020; Sevil-Serrano et al., 2020). These results

also seem to corroborate that, consistent with the original conceptualisation of the constructs of SDT, novelty could be fulfilled by need-supportive behaviours. According to Ryan and Deci (2017), each basic need satisfaction facilitates satisfaction of the other needs under most conditions, so it can be suggested that novelty seems to be consistent with the SDT motivational sequence (González-Cutre et al., 2020; González-Cutre and Sicilia, 2019). This is the first study that shows how the three BPN supports from PE teachers, analysed independently (i.e. autonomy, competence, and relatedness support), positively predicted students' novelty satisfaction in PE.

The prominent relationship between students' perceptions of PE teacher autonomy support and novelty satisfaction could be explained by the strong relationship suggested between autonomy and novelty satisfaction in PE (González-Cutre and Sicilia, 2019; González-Cutre et al., 2016). Therefore, autonomy-supportive strategies (e.g. encouraging students' interest and preferences, promoting choice and responsibility in their learning process, providing an explanation for undertaking an activity, etc.) could also be effective strategies to nurture students' sense of novelty. Similarly, given a positive relationship between students' perceptions of competence and relatedness support from PE teachers, and novelty satisfaction, providing competence-supportive strategies (e.g. providing individual and interrogative feedback, providing optimal challenges, etc.), and relatedness-supportive strategies (e.g. developing new, warm and close relationships) should be considered as satisfying novelty among students in PE. These mentioned strategies could help students to discover new possibilities in their search for a solution in terms of PE class tasks, with the support of different peers (Sevil-Serrano et al., 2020).

Nevertheless, although recent studies have provided evidence about the effectiveness of promising strategies to satisfy novelty (Fernandez-Rio et al., 2020;

Fernandez-Rio and Menendez-Santurio, 2017; Hernández et al., 2019; Sevil-Serrano et al., 2020; Vazou et al., 2019), further experimental research is needed to provide empirical evidence about how novelty could be satisfied. Moreover, given that only 31% of novelty satisfaction in PE was explained by the antecedents (i.e. need-supportive behaviours) of our hypothesised model, further studies are also needed to understand which additional social factors may have an influence on it. In this regard, future research should develop specific strategies aimed at supporting novelty in PE. Increasing knowledge about possible determinants of novelty satisfaction would allow PE teachers to design need-supportive strategies to satisfy novelty, which may also help to promote an active lifestyle among adolescents.

Practical implications for PE teachers, derived from our findings, deserve special attention. It can be said that our results seem to be in line with practical implications for PE teachers suggested by other studies (Fierro-Suero et al., 2020; González-Cutre and Sicilia, 2019), highlighting the importance of supporting students' BPNs of autonomy, competence, and relatedness (Escriva-Boulley et al., 2018). Novelty-supportive strategies should also be included, not only in the design of PE lessons but also in the daily interaction with students. For instance, proposing novel activities or teaching units (e.g. alternative sports such as 'Kin-ball', 'Parkour' or 'Colpbol') (Fernández-Río and Menéndez-Santurio, 2017; Hernández et al., 2019), using different motivation and behaviour change techniques (e.g. providing a meaningful rationale, exploring life aspirations and values, encouraging the experimentation of new behaviours, encouraging questions, helping to develop a clear and concrete plan of action, etc.) (Sevil-Serrano et al., 2020; Teixeira et al., 2020), teaching styles (e.g. reciprocal, guided discovery, divergent discovery, self-check) (Chatzipanteli et al., 2015), pedagogical models (e.g. teaching games for understanding, sport education, social responsibility,

gamification) (Casey and MacPhail, 2018; Fernandez-Rio et al., 2020), different materials (different types of balls, music, video, etc.) (Vazou et al., 2019), and implementing novel assessment systems (e.g. Motivating Assessment Mixing Console) (Slingerland et al., 2016) in the PE setting, could be promising strategies to enhance novelty satisfaction in PE among adolescents. It should be noted that evaluating students' previous experiences may be especially important to implement real novelty-supportive strategies. Yet, further experimental studies are required to corroborate the potential effects of these strategies.

Regarding the second aim, BPN and novelty satisfaction showed positive and significant associations with intention to be physically active. These results are broadly in line with previous research on BPN satisfaction and PA-related outcomes (Chen et al., 2020; Di Battista et al., 2018; Gunnell et al., 2016; Taylor et al., 2010). Yet, importantly, these results provide strong preliminary evidence about the fact that novelty satisfaction could also be an additional variable to be considered for PA promotion from an educational context, beyond the three BPNs.

In this sense, competence satisfaction in PE may help adolescents to participate in leisure-time PA thanks to previous satisfactory PE activities in which they have experienced success. Autonomy satisfaction in PE may help students to participate in PA outside school because they have received different options and possibilities in PE and, therefore, they can choose from a group of activities according to their interests. Moreover, if PE teachers provide students with autonomy and responsibility to organise and direct their own activities in PE, they could have more physical literacy skills to further manage their physical activities in their leisure time. Relatedness satisfaction in PE may encourage them to participate in PA with their peers or friends. Finally, if adolescents feel that their need for novelty in PE is satisfied through new content,

activities, materials, projects, methodologies, pedagogical models or technology, they might be more likely to feel a greater intention to continue experiencing new physical activities outside PE lessons (González-Cutre et al., 2020; Van Dongen et al., 2018). These results are in line with previous studies in leisure-time PA (Sylvester et al., 2018), that showed a positive relationship between perceived variety in PA and self-reported PA levels. Finally, according to SDT postulates, our results have shown that need-supportive environments in PE could indirectly affect intention to be physically active through novelty satisfaction and, therefore, the construct of novelty satisfaction could be essential to interpret empirical phenomena. This is the first study that tests this criterion for the need for novelty, so further studies are required to clarify this issue.

Limitations and perspective for future research

Several limitations of the present study should be acknowledged. First, given that the design of the study was cross-sectional, no causal conclusions can be inferred from the data. Using longitudinal or experimental designs would provide further understanding of the role played by novelty satisfaction in this model and would also clarify the causal direction of the proposed relationships. Second, the small number of PE teachers used to assess students' perceptions of need-supportive behaviours from PE teachers may induce nesting bias in adolescents' responses. Further studies should increase the number of PE teachers to provide more rigorous evidence. Third, our study was exclusively based on self-reported questionnaires. Using a mixed-methods approach (e.g. questionnaires, discussion groups or systematic observation instruments) with multiple informants, such as teachers and students, to triangulate results would provide a deeper understanding of the study variables. For instance, the use of systematic observation instruments to assess not only the frequency but also the intensity of need-

supportive behaviours from PE teachers (Quested et al., 2018), would contribute to further understanding its role in novelty satisfaction.

Future research directions are also provided in the present study. First, further research to evaluate moderating effects between BPN satisfaction and novelty satisfaction in PE would be interesting to conceptually advance this topic of study. Second, future research in PE should continue to test theoretical models, including novelty satisfaction in the motivational sequence of SDT, but using different PA-related outcomes (e.g. predisposition to PE). Similarly, it would be interesting to introduce a specific measure of novelty support as an antecedent in the motivational sequence, especially given that a questionnaire to measure this variable has been recently validated (Fierro-Suero et al., 2020). This research perspective would allow us to design more effective school PA intervention programmes in PE lessons. Third, it would also be interesting to analyse the effect of novelty satisfaction on PA-related outcomes assessed by objective methods of measure such as the Global Positioning System and accelerometers. Lastly, studying the effect of novelty frustration in PE on different PA-related outcomes would be a point of great interest in behavioural research.

Conclusions

The present study highlights the importance of teachers' autonomy, competence, and relatedness support in fostering not only students' BPN satisfaction but also novelty satisfaction in PE. Therefore, to satisfy novelty in PE and, consequently, develop an active lifestyle among adolescents, it becomes essential for PE teachers to design and implement need-supportive environments. To do that, it is necessary to continue to study the development of appropriate novelty support strategies such as the inclusion of novel elements in PE classes and the modification of traditional elements that make up

the curriculum (González-Cutre and Sicilia, 2019). The present study also highlights the role of novelty satisfaction in PE for PA promotion in youth. It has been shown that novelty satisfaction in PE is a positive and significant predictor of students' intention to be physically active outside school. In conclusion, providing novelty in PE classes seems to constitute an element to be considered in the promotion of adolescents' PA.

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Declaration of Conflicting Interests

The authors declare that no potential conflicts of interest exist with respect to the research, authorship, and/or publication of this article.

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Table 1

Means, standard deviations, reliability coefficients, and latent correlations among study variables.

Study variables	1	2	3	4	5	6	7	8
M (<i>SD</i>)	3.23 (1.09)	3.59 (1.08)	3.75 (1.14)	3.23 (1.05)	3.59 (0.98)	3.96 (0.86)	3.38 (1.05)	5.06 (1.67)
Cronbach's alpha	.83	.85	.88	.83	.82	.80	.90	.89
Omega coefficient (ω)	.81	.80	.82	.83	.80	.79	.89	.90
Average extracted variance	.52	.51	.64	.55	.51	.51	.62	.74
Latent correlations								
1. Autonomy support	-							
2. Competence support	.79	-						
3. Relatedness support	.69	.79	-					
4. Autonomy satisfaction	.74	.66	.62	-				
5. Competence satisfaction	.61	.77	.67	.79	-			
6. Relatedness satisfaction	.52	.61	.67	.62	.74	-		
7. Novelty satisfaction	.53	.52	.48	.67	.67	.51	-	
8. Intention to be physically active	.27	.32	.30	.40	.54	.46	.40	-

Note: All relationships were significant at $p < .01$ level.

Table 2

Fit indices of the theory-based model and the two alternative models.

	χ^2	df	χ^2/df	RMSEA	90%CI	CFI	TLI	AIC	BIC
Theory-based model	2148.965***	444	4.84	.059	.056-.061	.945	.938	100439.625	101001.863
First alternative model	1808.622***	310	5.83	.066	.063-.069	.941	.933	85969.197	86446.030
Second alternative model	2084.510***	448	4.30	.057	.055-.060	.947	.941	100445.225	101007.387

Note: *** = $p < .001$

Table 3

Effects of autonomy, competence, and relatedness support on intention to be physically active through BPN and novelty satisfaction.

	BPN satisfaction			Novelty satisfaction			Sum of indirect effects ($\alpha\beta$) 95% CI _{BC}
	α -coefficient 95% CI _{BC}	β -coefficient 95% CI _{BC}	$\alpha\beta$ -specific indirect effect 95% CI _{BC}	α -coefficient 95% CI _{BC}	β -coefficient 95% CI _{BC}	$\alpha\beta$ -specific indirect effect 95% CI _{BC}	
Autonomy support							
Intention to be physically active	.25** (.14, .35)	.37** (.28, .46)	.09** (.05, .13)	.29** (.17, .40)	.14* (.05, .22)	.04* (.01, .07)	.13** (.08, .18)
Competence support							
Intention to be physically active	.36*** (.23, .49)	.37** (.28, .46)	.13** (.07, .19)	.16* (.01, .31)	.14* (.05, .22)	.02 (.01, .05)	.15*** (.09, .22)
Relatedness support							
Intention to be physically active	.29** (.18, .38)	.37** (.28, .46)	.11** (.06, .15)	.15* (.04, .26)	.14* (.05, .22)	.02 (.01, .04)	.13** (.07, .18)

Note: * = $p < .05$; ** = $p < .01$; 95% CI_{BC} are reported between brackets

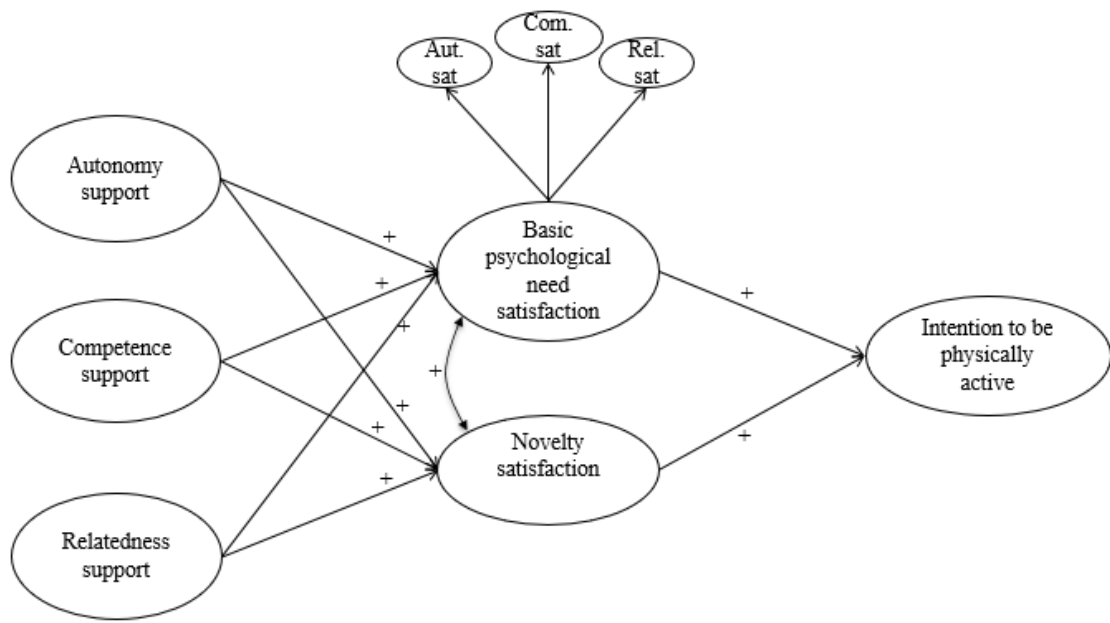


Figure 1. Hypothesised model of relationships between the study variables. Note: Aut. sat = Autonomy satisfaction; Com. sat = Competence satisfaction; Rel. sat = Relatedness satisfaction.

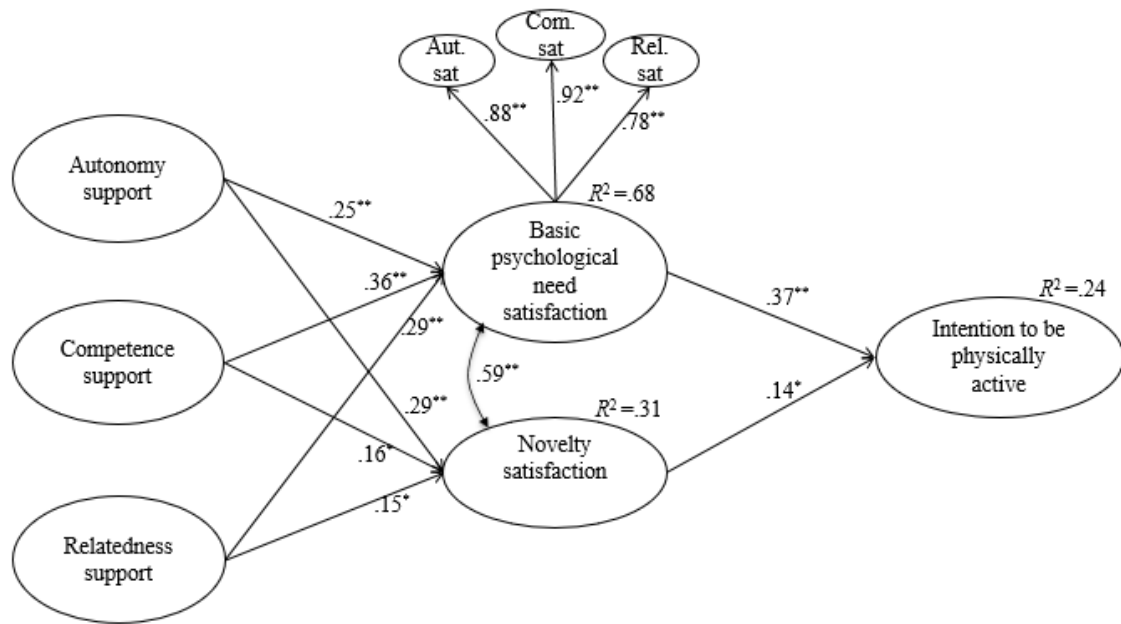


Figure 2. Results of the structural equation modelling.

Note: R^2 is over latent variables. * $p < .05$; ** $p < .01$; Aut. sat = Autonomy satisfaction; Com. sat = Competence satisfaction; Rel. sat = Relatedness satisfaction.