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ORIGINAL RESEARCH

Verification of the Reliability and Validity of the Chinese Version of the Novelty Need Satisfaction Scale in Physical Education

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Purpose: This study aims to validate the Chinese version of the Novelty Need Satisfaction Scale (NNSS) within physical education (PE) contexts, incorporating three distinct studies to examine its reliability, validity, and measurement invariance across gender and different samples.

Methods: Study 1 involved translating the original NNSS into Chinese and evaluating it through confirmatory factor analysis, item analysis, and assessments of internal consistency reliability among 390 students (53.8% male, 46.2% female), averaging 14.5 years in age. Study 2 assessed the discriminant validity of the Chinese NNSS by exploring correlations between novelty need satisfaction and three conventional basic psychological needs (BPNs) - autonomy, competence, and relatedness, in a larger cohort of 845 students (51.7% male, 48.3% female), with an average age of 14.8 years. This study also investigated the relationships between novelty need satisfaction, autonomous motivation, and enjoyment in PE. Study 3 examined the measurement invariance of the Chinese NNSS across gender and different samples, using a sample of 1235 students (52.6% male, 47.4% female), with an average age of 14.6 years.

Results: The one-factor, five-item structure of the Chinese NNSS was confirmed in Study 1. Study 2 demonstrated the distinct yet covariant nature of novelty need satisfaction among BPNs and its predictive capability for enjoyment in PE through autonomous motivation. Study 3 confirmed the measurement invariance of the Chinese NNSS across gender and samples, validating its reliability and applicability.

Conclusion: The validation of the Chinese NNSS within PE settings not only adds the need for novelty to the motivational sequence proposed by self-determination theory (SDT) but also emphasizes its significant role in enhancing autonomous motivation and enjoyment. This study suggests the scale's utility for future research in exploring the dynamics among BPNs and provides deeper insights into the motivational processes in PE.

Keywords: self-determination theory, basic psychological needs, cross-cultural validation, need for novelty

Introduction

Self-determination theory (SDT), introduced by Deci and Ryan,[1,2] focuses on explaining human motivational patterns, positing that individual behavior can be driven by various factors, such as influence from significant others, task value, personal interest, or external rewards and threats.[2] SDT classifies motivation into three types: intrinsic, extrinsic, and amotivation. Extrinsic motivation is further divided into integrated, identified, introjected, and external regulation. Intrinsic motivation involves engaging in activities for enjoyment, satisfaction, and accomplishment; fostering continuous engagement; challenge-seeking; and personal skill development, which are essential for cognitive and social growth.[2] Extrinsic motivation, influenced by social factors, can lead to action when internalized.[1,2] Integrated regulation, the most internalized form of extrinsic motivation, aligns with personal values and goals. Identified regulation is where actions are taken because they are deemed valuable, even if not inherently enjoyable. Introjected regulation drives behavior to gain approval or avoid negative feelings without genuine self-will. External regulation involves actions taken

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for rewards or to avoid punishment, lacking self-determination. Amotivation represents a lack of intention or belief in one's abilities, not falling within intrinsic or extrinsic motivation.[2]

Building on the SDT framework, Deci and Ryan also developed Basic Psychological Needs Theory (BPNT), a complementary sub theory. BPNT focuses on the needs for autonomy, competence, and relatedness. Autonomy is the feeling of being in control and having choices; competence relates to an individual's perception of his or her ability to perform tasks; and relatedness is the sense of connection with others and the surrounding world.[2] When these basic psychological needs are satisfied, motivation tends to be autonomous, leading to positive outcomes; conversely, when these needs are poorly met or frustrated, motivation leans toward controlled, resulting in negative consequences.[3]

As research on SDT has progressed, researchers have sought to explore additional basic psychological needs beyond these conventional three needs.[4] This endeavor seeks to offer a more comprehensive understanding of human motivation and the factors that motivate individuals in diverse contexts and scenarios. In their review of research related to basic psychological needs over the past two decades, Vansteenkiste et al[4] proposed five fundamental criteria and four additional criteria to define these needs. The five fundamental criteria are as follows: (1) psychological needs, comprising basic needs related to human psychological rather than physiological functions; (2) essential needs, the satisfaction of which is associated with adaptive outcomes, and their deprivation leads to maladaptive outcomes; (3) inherent needs, which represent an evolutionary perspective of our psychological essence; (4) distinct needs, which are stable and clear and do not emerge sporadically; and (5) universal needs, the satisfaction and frustration of which are consistent across cultures, personalities, and societal demographics. The four additional criteria include the following: (1) pervasiveness, by which the effects of experiencing these needs is reflected in various cognitive, affective, and behavioral outcomes; (2) content specificity, by which the satisfaction and frustration of these needs manifest through specific behaviors and experiences presented naturally and comprehensively; (3) directionality, by which basic needs can guide individuals in their thinking, actions, and feelings, thereby allowing them to actively seek environments, partners, and activities that support fulfilling these needs; and (4) explanatory, by which needs can explain or account for individuals' diverse positive and negative outcomes in social contexts. In accordance with these criteria, various candidates were discussed, among which the need for novelty was considered. Although Vansteenkiste et al[4] did not conclusively identify it as the fourth BPN, the need for novelty emerged as a significant factor in their deliberations. This underscores its potential importance and relevance in the context of BPNs, highlighting the need for further research and consideration of novelty as a vital component of human motivation and psychological well-being.

González-Cutre et al[5] first proposed the need for novelty as a possible candidate for an additional BPN. The definition of novelty is experiencing something that has not previously been experienced or that deviates from everyday routines.[5] González-Cutre et al[5] conceptualized the need for novelty based on a review of the relevant literature and examined the psychometric properties of the self-developed Novelty Need Satisfaction Scale (NNSS), assessing its discriminant and convergent validity by comparing it with the three basic psychological needs (autonomy, competence, and relatedness) and using life satisfaction and intrinsic motivation in PE as criteria for criterion-related validity. Their study was conducted in Spain and involved general adults and middle-school students who were participating in physical education (PE). In addition to confirming the positive relationship between novelty need satisfaction and individual well-being (ie, life satisfaction), they also established the construct validity of the NNSS in PE and identified its positive association with intrinsic motivation.[5] It has also been suggested that adding novelty need satisfaction to the three conventional BPNs enhances the explained variance in students' intrinsic motivation in PE.[5] Subsequently, González-Cutre and Sicilia[6] modified the original NNSS by removing one item, namely, "I have the opportunity to innovate", arguing that although the original scale had exhibited good validity in previous research, this item overlapped conceptually with the need for autonomy, thus justifying its removal. The revised five-item NNSS was used to examine how novelty need satisfaction, through the mediation of intrinsic motivation, predicts vitality, flow, and satisfaction among middle-school PE students in Spain.[6] González-Cutre and Sicilia[6] extended the adaptive outcomes associated with novelty need satisfaction and further integrated it into the realm of basic psychological needs. Benlahcene et al[7] translated the six-item NNSS[5] into Malay and used it to probe the relationship between novelty satisfaction and college students' engagement in PE in Malaysia. They found that novelty satisfaction predicted three aspects of students' engagement (behavioral, emotional, and cognitive) independent of the three conventional BPNs in SDT, suggesting that novelty is

a crucial motivational factor that should be considered along with the other BPNs proposed in SDT. A recent study by Aibar et al,[8] also in the Spanish context, demonstrated that support for the three conventional BPNs not only predicts the satisfaction of these three needs but also positively predicts novelty need satisfaction in PE. Moreover, the satisfaction of all four BPNs positively predicted students' intentions to be physically active. These investigations illustrated that both novelty need and the satisfaction of three conventional BPNs are positively correlated with intrinsic motivation and able to predict adaptive outcomes in PE. These research findings not only highlight the importance of satisfying students' need for novelty but also demonstrate that this notion represents a highly promising new direction for SDT in both theoretical and practical domains.

The reliability and validity of a measurement require the accumulation of empirical evidence over the long term. Although a series of studies have provided initial evidence regarding the reliability and validity of the NNSS(eg,[5,6,8]), these studies have focused on validating the satisfaction of novelty need as well as examining the relationships among novelty need satisfaction, motivation, and adaptive outcomes exclusively in the Spanish context. The reliability and validity of the NNSS, as well as the relationships among novelty need satisfaction, motivation, and PE outcomes in other cultures, especially in Eastern cultures, remain unclear. It has been suggested that cross-cultural examination of the NNSS is necessary for further research on the need for novelty.[5] Furthermore, the development of a measurement that exhibits high reliability and validity is a prerequisite for most research endeavors, particularly within the SDT framework.[3,4] For instance, Chen et al[9] developed the Basic Psychological Need Satisfaction and Frustration Scale (BPNSFS) by examining samples in Belgium, China, the USA, and Peru and found that the satisfaction and frustration of all three conventional BPNs predicts individuals' well-being and ill-being. Finally, versions of the BPNSFS have been made available in more than ten languages.[4] The items of the BPNSEFS have also been adjusted to accommodate specific contexts. The development of these measurements contributes to the enhancement of cross-contextual examinations.

Cross-cultural research on SDT has demonstrated the theory's broad applicability, indicating that despite cultural variations, the satisfaction of autonomy, competence, and relatedness needs is beneficial for students' motivation and well-being worldwide.[4] However, the cross-cultural examination of the novelty need, particularly within PE, remains underexplored. This gap is significant, given the increasing emphasis on cultivating a lifelong engagement with physical activity, necessitating an understanding of how diverse cultural contexts influence students' desire for and response to novel physical education experiences. Moreover, given that students' novelty need satisfaction enhances the explanatory power of the satisfaction of BPNs regarding adaptive outcomes in PE and the positive relationships between such satisfaction, intrinsic motivation, and adaptive outcomes, as indicated in previous studies,[6,8] measuring students' novelty need satisfaction is essential to further SDT research in PE. Translating and validating the Chinese NNSS not only paves the way for future research on the need for novelty in the Chinese context but also can help researchers further understand the relationships among the need for novelty, intrinsic motivation, and physical education outcomes in this cultural context. This process also facilitates identifying the teacher behaviors that may contribute to the satisfaction of students' need for novelty. Therefore, the development of the Chinese NNSS not only contributes to theoretical development by providing further evidence to support the inclusion of the need for novelty as a new BPN but also has practical implications. While the NNSS primarily evaluates the degree to which this need is currently being met, understanding these levels can indirectly guide teachers in developing instructional strategies. By identifying areas where novelty need satisfaction is low, educators can tailor their teaching approaches to better support and fulfill this need. Therefore, this study can serve as a foundation for developing instructional strategies to enhance need satisfaction, boost intrinsic motivation, and further improve adaptive outcomes in PE. Accordingly, this study aimed to translate the NNSS developed by González-Cutre et al[5] and González-Cutre and Sicilia[6] to examine its psychometric properties for PE students in Taiwan by employing a three-phase research design. Specifically, in Study 1, translation and back-translation procedures were employed, content validity was examined, and item discrimination analysis and confirmatory factor analysis (CFA) were performed. The internal consistency, reliability and construct validity of the scale were subsequently examined. In Study 2, the discriminant validity of the Chinese NNSS was examined in relation to the satisfaction of three conventional BPNs. Students' motivation and affective outcomes in PE were intended to serve as the criteria for concurrent validity. In Study 3, cross-validation and multigroup analysis based on gender and the stratification of the

samples from Studies 1 and 2 would be used to examine measurement invariance. The findings of this study are expected to render the reliability and validity of the Chinese NNSS more comprehensive and better supported. The Chinese NNSS is anticipated to provide a tool that enables researchers to compare the levels of novelty need satisfaction across different cultural contexts. This comparative analysis can deepen our understanding of how the satisfaction of the need for novelty varies globally, potentially revealing cultural influences on this BPN. Such cross-cultural studies are essential for validating the universality and cultural specificity of the novelty need within the broader framework of BPNs.

Study 1

Study 1 aimed to translate the NNSS developed by González-Cutre et al[5] and González-Cutre and Sicilia[6] into Chinese. Translation, back-translation, and content validity assessments were also employed. After the items of the Chinese NNSS were determined, preliminary reliability and validity examinations, such as CFA, item analysis, and internal consistency reliability assessments, were performed.

Materials and Methods

Participants and Procedure

A total of 390 students from 12 public middle and high schools across the North, South, Central, and Eastern regions of Taiwan participated in this study. The mean age of the participants was 14.5 years, and the participants included 210 males (53.8%) and 180 females (46.2%). Informed consent was obtained from the schools, participants, and parents. Participants were informed of the aims of this study and assured that their personal data and responses to the questionnaires would remain confidential and anonymous. They were also informed that they could choose whether to respond or not. To ensure that students felt more comfortable responding, their teachers were asked to leave during the response process. Generally, these approaches should have been able to ensure relatively low stress conditions for participants' responses.

Measurement

Novelty Need Satisfaction

González-Cutre et al[5] initially introduced the six-item NNSS and provided preliminary support for its reliability and validity. In subsequent research,[6] one item was omitted, resulting in a five-item NNSS. González-Cutre and Sicilia[6] further validated this five-item NNSS. In the present study, the translation and validation of the NNSS into Chinese were performed with meticulous attention given to detail. Initially, a diverse panel of experts was assembled, including individuals proficient in sport pedagogy, physical education, and bilingual translation. The team comprised four experts, who represented a balanced mix of demographic information and were proficient in both Chinese and English, ensuring a nuanced understanding of linguistic and cultural contexts. The translation process followed a rigorous translation and back-translation procedure. Each expert independently translated the NNSS into Chinese, followed by a collaborative review to reconcile any discrepancies. The back-translation was then carried out by a different set of bilingual experts, who were not privy to the original NNSS, to ensure the accuracy and fidelity of the translation. For content validity verification, a group of six sports pedagogy scholars, measurement experts, and PE teachers from middle and high schools with diverse backgrounds in terms of years of experience and geographical locations were invited. They meticulously reviewed the Chinese NNSS, providing feedback on each item's relevance and clarity. During this phase, any inconsistencies identified in the translated items were discussed extensively. The panel employed consensus-building techniques to resolve these discrepancies, ensuring that each item accurately reflected the intended construct while being culturally appropriate and understandable. Additionally, to assess the readability and comprehensiveness of the Chinese NNSS, five middle and high school students were asked to complete the scale. Their feedback was crucial in confirming that the items were age-appropriate and easily comprehensible for the intended demographic. The Chinese NNSS comprises five items, and all the items are scored on a 7-point Likert scale ranging from 1 ("not at all true for me") to 7 ("very true for me").

Data Analysis

After the questionnaires were retrieved, item discriminant analysis was conducted using SPSS 24.0 statistical software. Independent sample *t*-tests were used to examine the differences between the high-scoring group (top 27%) and the low-scoring group (bottom 27%) for each item.[10] Significant differences between the upper and lower groups were considered indicators that the data passed the item discriminant analysis. Subsequently, analyses of internal consistency reliability were conducted to assess the reliability of the instrument. This step is crucial for verifying that our instrument consistently measures the constructs of interest across various items. Thereafter, CFA was performed using the AMOS 24.0 statistical software package following the guidelines of Jackson et al.[11] The examination focused on the following aspects. 1. In terms of basic fit indices, nonnegative error variables were confirmed, and the researchers ensured that all estimated parameters had standard errors less than 1; 2. The comparative fit index (CFI), root mean square error of approximation (RMSEA), Tucker–Lewis index (TLI), and standardized root mean square residual (SRMR) were selected as model fit indices. The fitting standards included CFI greater than 0.90, RMSEA less than 0.10, TLI greater than 0.90, and SRMR less than 0.08.[12–14] These thresholds are commonly accepted standards indicating a good fit between the hypothesized model and the observed data.[15] In relation to composite reliability (CR) and average variance extracted (AVE), the formulas and recommendations provided by Bagozzi and Yi[16] were referenced, ie, CR = sum of squared standardized factor loadings/(sum of squared standardized factor loadings + sum of measurement errors), with CR exceeding 0.6 indicating satisfactory composite reliability, and AVE = sum of squared standardized factor loadings/(sum of squared standardized factor loadings + sum of measurement errors), with AVE exceeding 0.5 indicating desirable average variance extracted. Concerning convergent validity, acceptable convergent validity was affirmed when all item factor loadings exceeded 0.45 and were in the correct direction.

Results

The average scores for all the items were 4.76, 4.92, 5.03, 5.37, and 4.98 (*SD* = 0.64–0.71). The results of the independent samples *t*-test performed on the upper 27% and lower 27% for all items and the whole scale were considered significant ($p < 0.05$), suggesting that each item and the whole scale exhibited adequate power to distinguish among individuals in terms of their levels of novelty need satisfaction. Based on the CFA results of the five-item Chinese NNSS, the factor loadings of all the items fell between 0.72 and 0.79 (see Figure 1). The fit of the observational data to the model fell within the acceptable range (χ^2/df = 6.39; TLI = 0.94; CFI = 0.97; RMSEA = 0.10; SRMR = 0.03; $p <$. 05), except for the RMSEA, which tended to be overinflated under conditions of low degrees of freedom; thus, this statistic should not be relied upon in these cases.[17] The Chinese NNSS exhibited a CR value of 0.87, an AVE value of 0.57, a Cronbach's alpha coefficient of 0.87, and a McDonald's omega of 0.87, all of which were within the acceptable ranges. These results supported the structure of this one-factor, five-item Chinese NNSS.

Study 2

Study 2 was designed to assess both the discriminant and convergent validity of the Chinese Novelty Need Satisfaction Scale (NNSS) in PE. The focus was on evaluating how the satisfaction of the novelty need relates to three conventional BPNs, specifically examining whether it is a distinct construct and whether it aligns with related constructs as expected. In line with the theoretical framework of SDT, previous research has consistently shown

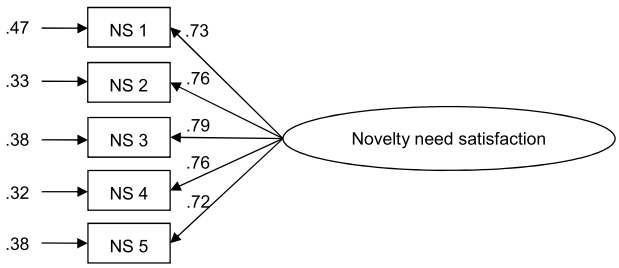

Figure 1 Validated structure of the Chinese NNSS.

that satisfaction of the novelty need positively predicts intrinsic or autonomous motivation in PE.[5,6,18,19] Furthermore, it has been established that this form of motivation can in turn predict adaptive outcomes such as enjoyment, vitality, and the intention to be physically active in PE, mediated by intrinsic or autonomous motivation.[5,8,20] Therefore, to assess the concurrent validity of the Chinese NNSS, we chose students' autonomous motivation and enjoyment in PE as key criteria. Building on the theoretical underpinnings of SDT, we hypothesized that the satisfaction of the novelty need of PE students would indirectly relate to, and positively predict, their enjoyment of PE. This prediction was premised on the concept that the level of students' autonomous motivation serves as an intermediary factor in this relationship. Our approach aimed to validate the NNSS by exploring its indirect relationships with established motivational and outcome variables in the context of PE. By demonstrating these indirect effects, we sought to reinforce the relevance of the NNSS within the motivational framework outlined by SDT, highlighting the importance of novelty need satisfaction in influencing students' motivation and enjoyment in PE.

Materials and Methods

Participants and Procedure

A total of 845 students from 21 public middle and high schools across the north, south, center and east of Taiwan participated in this study. The mean age of the participants was 14.8 years, and the sample included 437 males (51.7%) and 408 females (48.3%). The procedure was the same as that in Study 1.

Measurement

Novelty Need Satisfaction

The five-item Chinese NNSS developed in Study 1 was used to measure novelty need satisfaction in PE (eg, In PE, I frequently feel there are novelties for me). All the items were scored on a 7-point Likert scale ranging from 1 ("not at all true for me") to 7 ("very true for me").

Basic Psychological Need Satisfaction

The adapted Chinese version of the Psychological Needs Satisfaction Scale in Physical Education (PNSSPE)[21] was used. The PNSSPE comprises 18 items distributed evenly across three domains: six items for autonomy need satisfaction (eg, "In PE, I feel I can choose what I want to do".), six for competence need satisfaction (eg, "In PE, I have confidence that I can complete the tasks".), and six for relatedness need satisfaction (eg, "In PE, I feel the person I care about also cares about me".). Liu and Chung[20] verified the reliability and validity of this scale by employing a comprehensive series of validation procedures. In the present study, all items were scored on a 7-point Likert scale ranging from 1 ("not at all true for me") to 7 ("very true for me").

Autonomous Motivation

The subscales of intrinsic motivation (4 items, eg, "because it is fun") and identified regulation (4 items, eg, "because I want to learn sport skills") from the Perceived Locus of Causality scale[22,23] were employed to assess the autonomy-oriented motivation of physical education students in this study. This scale was originally developed by Goudas et al[22] and subsequently adapted by Standage et al[23] to suit the context of PE. All the items were scored on a 7-point Likert scale ranging from 1 ("not at all true for me") to 7 ("very true for me"). Following the suggestion of Ntoumanis and Standage,[24] autonomous motivation was calculated in terms of the average score of intrinsic motivation and identified regulation.

Enjoyment

Students' enjoyment of PE was assessed using a modified sport enjoyment scale.[25] This four-item scale was modified to focus on the school PE setting (eg, I think PE is fun), and students responded to items on a 7-point Likert scale ranging from 1 ("not at all true for me") to 7 ("very true for me").[26]

Data Analysis

Regarding convergent validity, when the factor loadings for all items exceeded 0.45 and were in the correct direction, the data were considered to exhibit acceptable convergent validity. With respect to discriminant validity, a comparison was made between novelty need satisfaction and the satisfaction of the three conventional psychological needs (ie, autonomy, competence, and relatedness). Initially, interfactor correlations were fixed at 1 in the models. This process involved conducting tests of model fit using both an unrestricted model (in which interfactor covariances were not constrained and covariance parameters were free parameters) and a restricted model (in which interfactor covariances were constrained to be 1 and covariance parameters were fixed parameters). Regarding discriminant validity, an appropriate average variance extracted (AVE) analysis was necessary to determine whether the square root of every AVE value for each latent construct was substantially larger than any correlation among any pair of latent constructs.[27] The square root of the AVE of each construct should be substantially larger than the correlation of that specific construct with any of the other constructs. Furthermore, the AVE value for each construct should be at least 0.50.[28]

Regarding concurrent validity, this research investigated whether novelty need satisfaction among physical education students was positively correlated with autonomous motivation and enjoyment. Additionally, the study investigated whether autonomous motivation mediated the relationship between novelty need satisfaction and enjoyment. The data analysis was conducted using AMOS 24.0 statistical software, and the approach was guided by the recommendations of Jackson et al.[11] The chosen fit indices were the CFI, RMSEA, TLI, and SRMR. The fitting criteria for each index were consistent with those used in Study 1.[12–14] Subsequently, when the data satisfied the aforementioned criteria, the interpretation proceeded by determining the path coefficients and significance levels. Regarding the examination of the mediating effects, if the direct effects were significant, a bootstrapping approach was employed to calculate the indirect effects and 95% confidence intervals of the paths.[29] If the 95% confidence interval did not encompass 0, the mediating effect was considered to have been established.[30]

Results

Convergent Validity and Discriminant Validity

In assessing convergent and discriminant validity, a CFA for the four constructs—three basic psychological needs and novelty—revealed that all items exhibited factor loadings above 0.45, and converged in the correct direction, good convergent validity was demonstrated.16. Figure 2 shows that the factor loadings of all the items exceeded 0.45. The items were effectively loaded onto their respective factors, indicating appropriate convergent validity. In addition, Table 1 suggests that the √AVE value should be higher than the correlations between the construct in question and other constructs. The results of the √AVE values of the four factors were 0.75, 0.76, 0.79, and 0.77. Table 1 also shows that all √AVE values were higher than the correlation coefficients between the constructs in question and other constructs, thus supporting the discriminant validity of the model.

Concurrent Validity

The relationships among novelty need satisfaction, autonomous motivation, and enjoyment were examined. The results of structural equation modeling (SEM) with maximum likelihood estimation showed that the results of various fit indices suggested that the hypothesized model was acceptable (χ^2/df = 5.61; TLI = 0.95; CFI = 0.95; RMSEA = 0.07; SRMR = 0.04; $p < 0.05$). As shown in Figure 3, the standardized path coefficients for novelty need satisfaction, autonomous motivation, and enjoyment were 0.65, 0.22, and 0.57, respectively. Bias-corrected 95% confidence intervals (CIs) were used in the present study to identify significant mediating effects.[29] A significant effect was evident when the bootstrap-generated 95% CI did not contain zero.[29,31] Novelty need satisfaction significantly predicted enjoyment in PE through autonomous motivation ($\beta = 0.38$, 95% CI= 0.31–0.45, $p < 0.001$). The percentage of the total effect accounted for by the indirect effect indicated the degree of mediation. The percentage of the total effect of novelty need satisfaction on enjoyment that was mediated by autonomous motivation in PE was 81%.

In general, our hypothesized paths, according to which novelty need satisfaction positively predicts enjoyment in PE through the mediation of autonomous motivation, were supported.

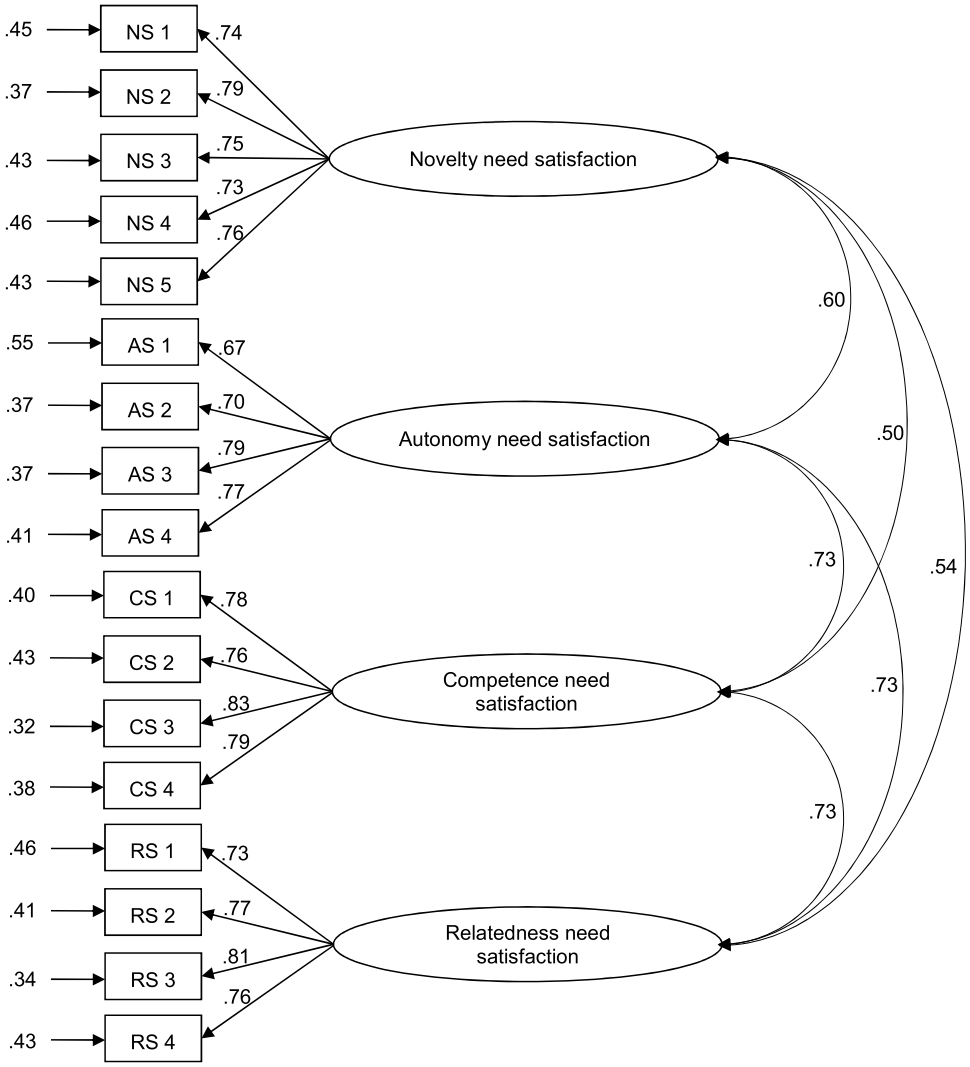

Figure 2 Confirmatory Factor Analysis of the Four Basic Psychological Needs.

Study 3

Study 3 aimed to examine the cross-validity of the Chinese NNSS by using multiple-group analysis to examine the data invariance of the samples investigated in Study 1 and Study 2 as well as to explore the effects across different genders.

Table 1 Descriptive Statistics and Bivariate Correlations According to the Discriminant Validity Tests

Factor	*M*	*SD*	NS	AS	CS	*RS*
NS	5.20	1.07	(0.75)			
AS	4.97	1.18	0.60	(0.76)		
CS	4.74	1.26	0.50	0.73	(0.79)	
RS	4.89	1.22	0.54	0.73	0.73	(0.77)
N=845						

Note: $p < 0.05$.
Abbreviations: NS, novelty need satisfaction; AS, autonomy need satisfaction; CS, competence need satisfaction; *RS*, relatedness need satisfaction; the √AVE value for each factor is shown in parentheses.

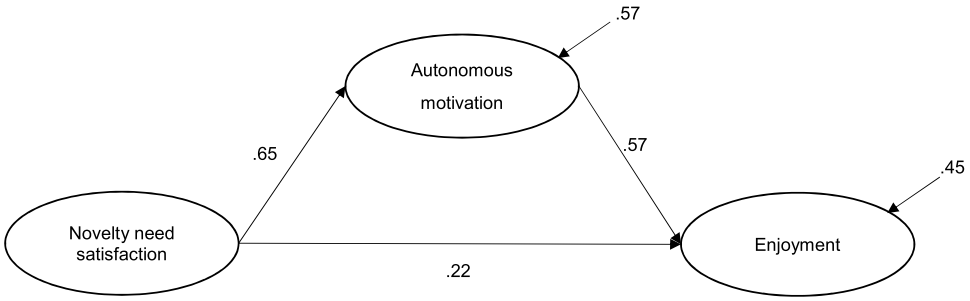

Figure 3 Structural model with standardized path coefficients.

Materials and Methods

Participants and Procedure

The participants in this study were 1235 students from study 1 and study 2. The mean age of the participants was 14.6 years, and the sample included 649 males (52.6%) and 568 females (47.4%).

Measurement

Novelty Need Satisfaction

The five-item Chinese NNSS developed in Study 1 was used to measure novelty need satisfaction in PE. All the items were scored on a 7-point Likert scale ranging from 1 ("not at all true for me") to 7 ("very true for me").

Data Analysis

Multigroup analysis was employed to assess the invariance of the Chinese NNSS across gender and the participant samples from Studies 1 and 2. This analysis involved a systematic comparison of unconstrained and constrained models, as per the guidelines outlined by Byrne et al.[13] Specifically, we began with an unconstrained model in which all the parameters were freely estimated. Then, we progressively imposed constraints across groups on key model parameters (eg, factor loadings, intercepts) to test for configural, metric, and scalar invariance. To evaluate the fit of these models and the degree of invariance, we employed several statistical indicators. The RMSEA and changes in the Normed Fit Index (ΔNFI) were particularly critical, The NFI, as a measure assessing the model fit by comparing the chi-square value of the hypothesized model to the chi-square value of the null model, with values less than 0.10 indicating an acceptable model fit and invariance. Additionally, we considered the expected cross-validation index (ECVI). According to Little,[32] ECVI point estimates and their average confidence intervals should be above 0.09 for moderate support of model cross-validation. All analyses were conducted using AMOS 24.0 statistical software.

Results

Multigroup analysis was performed to examine the data invariance of the samples used in Study 1 (n = 390) and Study 2 (n = 845) with the goal of confirming the cross-validation of the Chinese NNSS. As indicated in Table 2, the RMSEA (0.09, 0.08, 0.08, 0.07) and ΔNFI (0.00, 0.00, 0.00) values were < 0.05, and the ECVI values fell within the confidence intervals of above 0.09 for models between loose and tight replications, thus indicating that the two samples were equivalent to the factor loadings across the samples; these findings served as supporting evidence for the cross-validation of the Chinese NNSS.

Multigroup analysis was also performed to examine the data invariance across different genders (male=649, female=586) to further confirm the cross-validation of the Chinese NNSS. As indicated in Table 2, the RMSEA (0.09, 0.08, 0.07, 0.07) and ΔNFI (0.00, 0.00, 0.01) values were < 0.05, and the ECVI values fell within the confidence intervals of above 0.09 for models between loose and tight replications, thus indicating that the two samples were equivalent to the factor loadings across the samples; these findings served as supporting evidence for the gender invariance of the Chinese NNSS.

Table 2 Results of the Cross-Validation Tests

	Model	x^2	*df*	*p*	RMSEA	ΔNFI	ECVI (0.90 CI)
Study 1 and 2 samples	Unconstrained	121.62	10	–	0.09	–	0.147 (0.121~0.179)
	Measurement weights	125.84	14	0.38	0.08	0.00	0.144 (0.118~0.176)
	Structural covariances	125.96	15	0.73	0.08	0.00	0.174 (0.143~.212)
	Measurement residuals	129.82	20	0.56	0.07	0.00	0.170 (0.139~0.208)
Gender	Unconstrained	122.18	10	–	0.09	–	0.148 (0.122~0.180)
	Measurement weights	127.75	14	0.23	0.08	0.00	0.146 (0.119~0.178)
	Structural covariances	128.73	15	0.32	0.07	0.00	0.145 (0.119~0.177)
	Measurement residuals	154.15	20	0.00	0.07	0.01	0.154 (0.128~0.193)

General Discussion

For decades, SDT has achieved considerable success in explaining human motivation based on three basic psychological needs. Nonetheless, the need for novelty, as a newly emerging basic psychological need, may play a crucial role in SDT, similar to the three conventional BPNs (ie, autonomy, competence, and relatedness).[4] This study examined the reliability and validity of the Chinese version novelty need satisfaction scale (the Chinese NNSS) in the context of PE; this scale was adapted from the original NNSS developed by González-Cutre and Sicilia.[6] By conducting three serial studies, it was confirmed that the Chinese NNSS comprises 1 factor and five items, the same as the original NNSS.

In a series of studies, the original NNSS[5,6] was adapted into Chinese using a rigorous back-translation and expert validation process, establishing its preliminary reliability and validity. The Chinese NNSS, mirroring the one-factor, five-item structure of the original, was validated, indicating that PE students in Taiwan, like their Spanish counterparts, perceived their need for novelty as being satisfied. This finding echoes the work of González-Cutre et al[5] who proposed the NNSS and its potential universality across different cultures by highlighting its psychometric properties and discriminant validity with other psychological needs. The discriminant validity of the Chinese NNSS was further affirmed in relation to the three conventional BPNs of autonomy, competence, and relatedness, a finding that aligns with the cross-cultural findings of González-Cutre et al[6] who provided evidence for novelty as a distinct and complementary BPN within SDT across Spanish adults. Positive correlations among these four BPNs supported the inclusion of novelty as the fourth BPN in SDT, as previously suggested,[5,6,20] but also resonate with the validation of the Spanish version of the scale, which confirmed novelty's role in enhancing physical education experiences.

Additionally, SEM and bootstrapping analysis revealed that novelty need satisfaction in PE students positively predicted their enjoyment via autonomous motivation, a pattern consistent with Trigueros et al.[33] Finally, the measurement invariance of the Chinese NNSS was confirmed across gender and samples, reinforcing its effectiveness as an assessment tool for the satisfaction of the need for novelty in PE contexts. The findings suggested that novelty need satisfaction has direct effects on autonomous motivation and enjoyment in PE, which is consistent with SDT and in line with previous studies.[5,8] Nonetheless, the satisfaction of the need- for novelty and enjoyment did not exhibit a very strong correlation. Future research should empirically examine models that introduce novelty into the motivational sequence within the framework of SDT. Such a sequence should expand our knowledge of the intricate mechanisms by which the provision of environmental support for BPNs ultimately leads to adaptive outcomes through the mediation of the satisfaction of these needs and subsequent motivational patterns.

Furthermore, satisfaction of the need for novelty may be more closely linked to experiences of stimulation and learning new things in the context of autonomous motivation. Likewise, satisfaction of the need for novelty could explain more variance in some variables, such as creativity, engagement, and physically active intention. It is thus also crucial to validate items that can assess the frustration of the need for novelty and the corresponding effects in the Chinese context with the goal of expanding on recent approaches to the study of basic psychological needs.[34] Examining the interactions among different basic psychological needs in the Chinese context is also a pertinent avenue for investigation. Novelty need satisfaction may have positive effects on the improvement of adaptive outcomes only when the other three BPNs are not frustrated. Individuals want to engage in novel activities only if such activities do not threaten other BPNs, such as

learning a new skill that is too difficult to master or the decision to implement a different teaching strategy being made solely by the teacher. It would be interesting to establish motivational profiles based on the satisfaction of these four BPNs to analyze how variations in needs satisfaction are related to different outcomes in the Chinese PE context.

This study answered the call for the development of measurements of novelty need satisfaction by González-Cutre et al[5] and Vansteenkiste et al[4] and furthered the development of the NNSS by examining its reliability and validity in cultural groups that are distinct from those on which previous studies have focused. To our knowledge, the Chinese NNSS developed in the present study is the first self-report tool that can be used to measure novelty need satisfaction in the Chinese PE context. The Chinese NNSS can be used in the Chinese context to measure students' satisfaction of the need for novelty and analyze the relationships among novelty need satisfaction, motivations, and other outcomes in PE. Nonetheless, several limitations of the present study should be addressed. First, the cross-sectional design of this study prohibited us from making inferences regarding the causal effects among novelty need satisfaction, autonomous motivation, and adaptive outcomes in PE. Future researchers should conduct longitudinal studies to examine how novelty need satisfaction influences students' motivation and learning outcomes in PE. Importantly, future studies are also suggested to incorporate autonomy, competence, and relatedness need satisfaction - within the analytical models to evaluate to the predictability of novelty need satisfaction on autonomous motivation, enjoyment, or other adaptive outcomes in PE beyond the conventional three BPNs. In addition, given the self-reported design of the NNSS, it's crucial to acknowledge potential response biases, including social desirability. Mitigation strategies, like indirect questioning, validated scales for bias assessment, or data triangulation, could help minimize or highlight these biases' effects on the findings. Experimental designs are crucial for validating the effects of novelty need support in PE, particularly regarding its impact on adaptive outcomes such as autonomous motivation, engagement and physical activity in PE quantitatively.[35] It also promotes sustained engagement in physical activities, contributing to overall physical health and wellness. This is especially pertinent after the implementation of distance learning during the COVID-19 pandemic, which led to students spending prolonged periods on their mobile phones, experiencing a lack of interpersonal interaction, and exhibiting diminished motivation for participation.[36] Furthermore, the participants in the present study were teenagers in middle and high school, and future researchers should test the invariance of the Chinese NNSS among other age groups (eg, adults or primary school pupils) to enhance the validity of this measurement.

Ethics Approval

The study was conducted in accordance with the Declaration of Helsinki and approved by Research Ethics Committee National Taiwan University (reference: 202112ES052).

Informed Consent

Written informed consent was obtained from all individual participants and their parents included in the study.

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Disclosure

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