# Basic psychological need satisfaction in active commuting to and from school BPNS-ACS(SWE)

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ARTICLE INFO

*Keywords:*
Need satisfaction
Need-based experiences
Active transport to school
Active school commuting
Children

ABSTRACT

*Background:* The absence of appropriate Swedish-language instrumentation to assess active commuting to school has largely hampered the study of the individual factors of the children, such as autonomy, competence, and relatedness to active commuting to school.
*Purpose:* Building upon self-determination theory, the objective of this research was to gather evidence of the validity and reliability of the Swedish version of the Basic Psychological Need Satisfaction in Active Commuting to and from School (BPNS-ACS) tool.
*Methods:* The cross-sectional and purposive sample included 273 children (51.28% girls) from urban areas.
*Results:* Confirmatory factor analysis underpinned the three-factor correlated model, which was invariant across gender. Evidence in support of discriminant and convergent validity and reliability was gathered. Criterion validity evidence was met by positive and significant predictions of autonomy, competence, and relatedness satisfaction on active commuting to and from school.
*Conclusions:* The Swedish version of the BPNS-ACS is a psychometrically robust measure of children's perceptions of autonomy, competence, and relatedness satisfaction in active commuting to school and could be used to assess the effects of school-based interventions on need satisfaction for active commuting to school.

## 1. Introduction

Active commuting to and from school (ACS) (e.g., walking, cycling, skateboarding, in-line skating, or cross-country skiing) is one low-cost and sustainable manner to help young people meet daily physical activity recommendations (Larouche et al., 2020; Masoumi et al., 2020). ACS also has the potential to improve children's health, emotional well-being, and personal development and enhance their cardiorespiratory fitness, corporal composition, and academic achievement (Campos-Sanchez et al., 2020; Larouche et al., 2020; Lubans et al., 2009). Despite the numerous benefits of active commuting to school, recent research has reported a worldwide decline in ACS (Grize et al., 2010; Chillón et al., 2013; Pavelka et al., 2017; Rothman et al., 2017). In Sweden, the prevalence of ACS among children between 6 and 15 years old declined from 62.90% in 2012 to 48% in 2018 (Swedish Transport Administration, 2018). Given

that levels of ACS worryingly declined, there is a need to determine the main factors underlying ACS behavior to design and implement effective intervention programs to promote ACS among children. These interventions can play a crucial role in promoting health, mitigating climate change, and improving the environment, all of which are large societal challenges and important focuses for research and political priorities (Badland and Schofield, 2005).

Moreover, ACS behavior is influenced at several levels by a wide range of individual, social, built environment, and policy factors (Mitra, 2013; Rothman et al., 2017). Within the individual level, research is still describing and identifying the potential determinants of ACS, suggesting children's perceptions of autonomy, competence, and relatedness as potential correlates of ACS (Burgueño et al., 2020, 2022; Zaragoza et al., 2020). Self-determination theory (SDT) (Ryan and Deci, 2017), especially through the concept of basic psychological needs, is a consistent theoretical model that could provide a plausible explanation system for the use of active modes to commute to and from school in children and adolescents (Burgueño et al., 2020, 2022).

### 1.1. Self-determination theory: basic psychological needs

SDT is a macro-theory of human motivation and personality development consisting of six mini-theories (Ryan and Deci, 2017). One mini-theory is the basic psychological need theory, which holds that people are inherently moved toward personal development and integration, and hence towards learning, mastery, and connection with others (Ryan and Deci, 2020). Nonetheless, these proactive human manifestations are not considered automatic but require supportive elements to satisfy the basic psychological need for autonomy, competence, and relatedness (Vansteenkiste et al., 2020). Autonomy satisfaction refers to a sense of behavioral initiative and ownership in one's actions. Competence satisfaction refers to the perception of efficacy and mastery and the sense that one can succeed in environmental interactions. Relatedness satisfaction refers to a sense of belonging and connection and the perception of respect and mutual caring.

Consistent with the SDT assumptions, autonomy, competence, and relatedness satisfaction perform an energizing role in the development and maintenance of the internalization process, well-being, as well as adaptive affective, behavioral, and cognitive outcomes (Ryan et al., 2021; Vansteenkiste et al., 2020). Although there is little research examining need satisfaction in the specific context of active commuting to school, positive and significant relationships between the student's perception of autonomy, competence, and relatedness satisfaction and their ACS behavior have been described (Burgueño et al., 2020, 2022; Zaragoza et al., 2020). More specifically, Burgueño et al. (2020) discovered that competence satisfaction had a stronger prediction than autonomy and relatedness satisfaction on ACS among children and adolescents.

### 1.2. Measuring autonomy, competence, and relatedness satisfaction in ACS

To deeply analyze the children's experiences of need satisfaction underpinning ACS behavior at the international level, and at the Swedish level, in particular, there is a need to have available appropriate instrumentation. While no evidence so far was found of SDT-based measures of autonomy, competence, and relatedness satisfaction in the Swedish context of ACS, the Basic Psychological Needs Satisfaction in Active Commuting to and from School (BPNS-ACS) scale was developed for international use to assess the positive experiential estate that occurs when children and adolescents perceive their basic psychological needs as satisfied within the context of ACS (Burgueño et al., 2020). BPNS-ACS includes three factors representing the hypothesized interrelated dimensions of autonomy, competence, and relatedness satisfaction (i.e., a three-factor correlated model). The validation study (Burgueño et al., 2020) gathered evidence in support of internal structure validity for the three-factor correlated model and their invariance across gender and age, reliability, and discriminant, convergent, and criterion validity.

More recently, the BPNS-ACS has been adapted to the Portuguese and Polish contexts of ACS using samples of children and adolescents (Dzielska et al., 2021; Marques et al., 2021). The different psychometric tests revealed good psychometric properties for the Portuguese instrument's version (Marques et al., 2021), whereas various psychometric limitations were found for the Polish adaptation (Dzielska et al., 2021). Specifically, the autonomy satisfaction factor had unsatisfactory scores in composite reliability and average variance extracted, which could jeopardize evidence for the reliability and convergent validity of one of the factors comprising this instrument.

### 1.3. The present study

To effectively promote ACS among children, it is important to obtain an in-depth insight into the main determinants of ACS behavior, and the SDT framework potentially provides researchers with an avenue to do this. However, the efforts to date have been hampered by the absence of comprehensive instrumentation in the Swedish language. The availability of well-validated measures of autonomy, competence and relatedness satisfaction help researchers ascertain the distinctive role that these psychological experiences may play in ACS behavior and, in consequence, contribute to the change of the behavior in question. Once their role was identified, behavior change intervention programs aiming to increase ACS levels may be implemented with the put focus on the development of the children's experiences of autonomy, competence and relatedness satisfaction in active travels to school.

Therefore, the objective of this research was to adapt the BPNS-ACS to the Swedish context of ACS and to provide evidence of validity and reliability for the resulting version (BPNS-ACS(SWE)) using a sample of children. Following SDT (Ryan and Deci, 2020; Vansteenkiste et al., 2020) and previous studies on active commuting to school (Burgueño et al., 2020, 2022; Zaragoza et al., 2020), we hypothesized that the children's perception autonomy, competence, and relatedness satisfaction would positively and significantly predict ACS behavior.

## 2. Method

### 2.1. Study design and participants

A cross-sectional study design included a sample of 273 respondents (140 girls and 133 boys) recruited from four public schools through contact with two municipalities in Sweden. The municipalities are about 900 km apart (latitudinal direction), covering different Swedish weather conditions. The municipalities invited leaders of their schools to participate with students from grades 4–6 (aged 10–12 years). All schools were in urban areas. See Table 1 for the participants' characteristics.

### 2.2. Measures

#### 2.2.1. Basic psychological needs satisfaction

Our starting point to measure basic psychological needs satisfaction was the Spanish version of the BPNS-ACS questionnaire (Burgueño et al., 2020). It comprises 12 items divided over three factors to measure autonomy, competence, and relatedness satisfaction. The items are scored on a 5-point Likert-type scale, from 1 (strongly disagree) to 5 (strongly agree). The Spanish BPNS-ACS was translated to Swedish following the guidelines outlined in Wild et al. (2005). Two independent translators translated the Spanish questionnaire into Swedish. The translated version was discussed among a group of translators, researchers, and teachers to find the right words for the Swedish context and the slightly lower age of the children. Then, the questionnaire was translated back to Spanish by a translator not involved earlier in the process, after which the back-translated version was discussed with the original developers. A pilot study of cognitive interviews was conducted with Swedish children aged 10–12 years, and minor changes were made according to these findings and tested in another interview round. The process has provided evidence for validity based on the instrument content when used with Swedish children aged 10–12 years. This Swedish version, BPNS-ACS(SWE), was then used to measure satisfaction with the three basic psychological needs of autonomy, competence, and relatedness.

#### 2.2.2. Mode of commuting

To register the mode of commuting to and from school, a diary-type questionnaire was developed, following the published recommendations (Chillon et al., 2017; Segura-Díaz et al., 2020). Students registered their commuting mode for 1 week, resulting in a maximum of ten separate trips.

### 2.3. Data analysis

G*Power 3.1.9.7 (Faul et al., 2007) was used to calculate the sample size required for this research. Following the parameters of effect size $f^2 = 0.01$, $\alpha = 0.05$, statistical power = 0.95, and three latent variables, a minimum sample of 220 participants were needed to ensure the trustworthiness of the results. A confirmatory factor analysis (CFA) and a multi-group analysis of invariance were tested to analyze validity based on the instrument's internal structure. CFA was performed using the robust maximum likelihood (MLR) estimator implemented in Mplus 8.4 (Muthén and Muthén, 2015). Assessment of the goodness of the model's fit was made following an array of fit indexes: the coefficient between $\chi^2$ and degrees of freedom ($\chi^2$/df), Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), Standardized Root Mean Square Residual (SRMR), and Root Mean Square Error of Approximation (RSMEA) with its confidence interval at 90% (90%CI). A suitable fit to data is achieved with values as high as 5 for the $\chi^2$/df coefficient, over 0.90 for CFI and TLI and up to 0.080 for SRMR and RSMEA (Hair et al., 2018). Standardized regression weights are appropriate, with values above 0.40 (Hair et al., 2018). Moreover, the multi-group analysis of gender invariance followed the sequence described by Putnick and Bornstein (2016): configural invariance (no equality restrictions), weak invariance (equal factor loadings in items), strong invariance (equal factor loadings and intercepts in items), and strict invariance (i.e., equal factor loadings, intercepts, and error variance in items). Differences in CFI of up to 0.010 and RMSEA of up to 0.015 between each two increasingly restrictive models would support the invariance assumption (Putnick and Bornstein, 2016).

After verifying the strong invariance assumption, latent mean differences by gender were analyzed using the Z-value (Kline, 2016). For these tests, the latent mean scores for girls were restricted to zero, while they were freely computed for boys (Kline, 2016). To examine the instrument's reliability, Cronbach's alpha, Raykov's composite reliability coefficient, and McDonald's omega were estimated for each factor. Good reliability is obtained when values are higher than 0.70 (Viladrich et al., 2017).

The average variance extracted (AVE) was calculated to assess the instrument's convergent validity with values above 0.50 as appropriate (Hair et al., 2018). Discriminant validity was inspected with values as high as 0.80 both in latent inter-factor correlations

**Table 1**
Participant characteristics.

| | | |
|---|---|---|
| Sex | Girls | 140 |
| | Boys | 133 |
| Grade | Grade 4 | 48 |
| | Grade 5 | 187 |
| | Grade 6 | 38 |
| Commuting trips/week (number) | Active | 1030 |
| | Passive | 697 |

and the heterotrait-monotrait ratio of correlations (HTMT) (Henseler et al., 2015), as well as with the Fornell and Larcker's (1981) criterion, according to which there is discrimination among two factors when the squared AVE score is higher than the correlation in question.

To analyze the instrument's criterion validity, a two-step structural equation modeling (SEM) was run (Kline, 2016) with the robust maximum likelihood (MLR) estimator (Muthén and Muthén, 2015). The first step (i.e., measurement model) examined the bidirectional relationships among the target variables. The second step (i.e., structural model) analyzed autonomy, competence, and relatedness satisfaction's predictive effects on ACS. As SDT-based research on active commuting to school has observed that need satisfaction could vary depending on gender (Burgueño et al., 2020), the model was controlled for gender. Finally, descriptive statistics were calculated for each variable under study. Data were analyzed using Mplus version 8.4 and SPSS version 28.00.

## 2.4. Ethics

The study was performed following the ethical principles of the World Medical Association's Declaration of Helsinki. The study was approved by the Ethics Review Authority in Sweden before the start of the research project (Dnr: 2021–03783).
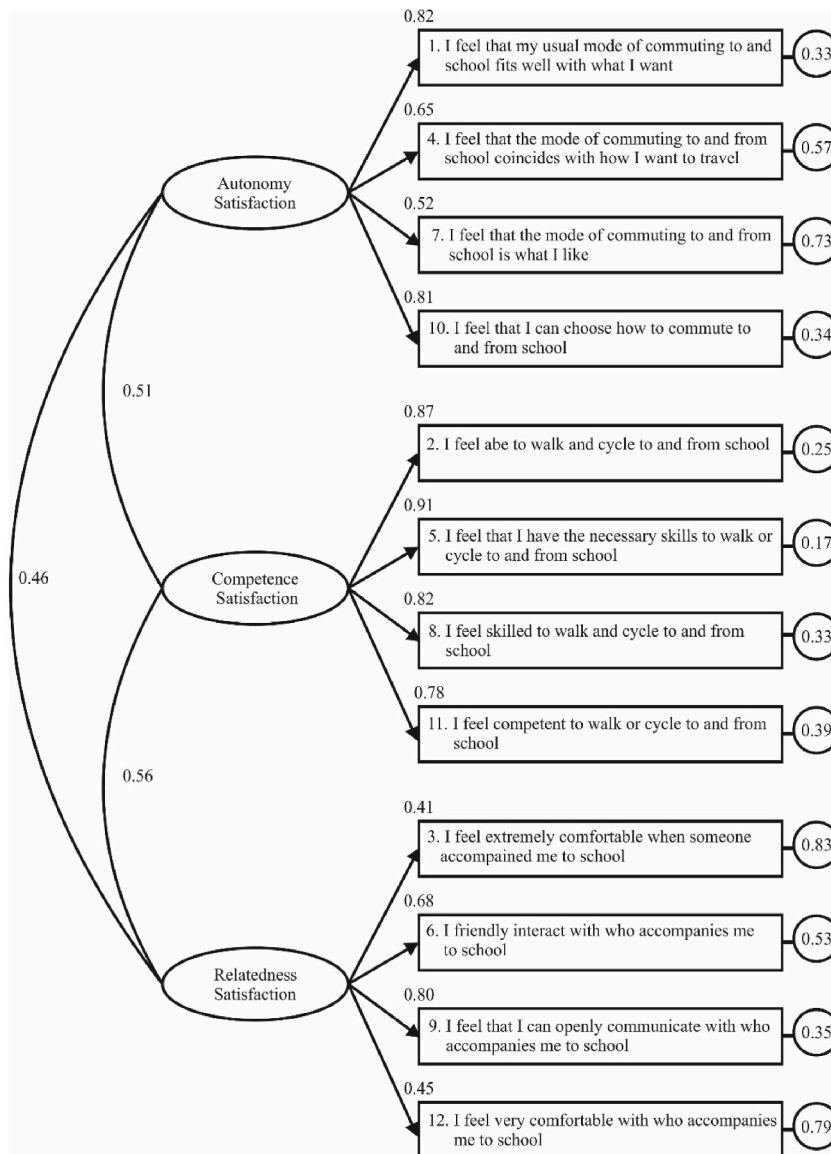


**Fig. 1.** Confirmatory factor analysis for the Swedish version of the Basic Physical Need Satisfaction in Active Commuting to School Scale. Note. Ellipses represent latent variables, rectangles represent manifest variables, and small circles represent items' error variance.

## 3. Results

### 3.1. Confirmatory factor analysis

The 12-item three-factor correlated model obtained a good fit to data: $\chi^2$ ($df = 51$) = 93.571, p < 0.001; $\chi^2/df$ = 1.835; CFI = 0.944; TLI = 0.926; SRMR = 0.054; RMSEA = 0.058 (90%CI = 0.039–0.076). Fig. 1 shows that the standardized regression weights were statically significant ($p < 0.001$) with values between 0.41 and 0.91.

### 3.2. Invariance across gender

Table 2 shows the results from the multi-group analysis for gender invariance. There were differences in CFI and RMSEA lower than 0.010 and 0.15 among the two progressively restrained models, respectively. Thus, the invariance assumption was supported across Swedish male and female samples.

### 3.3. Reliability, convergent and discriminant validity

Table 2 shows values between 0.76 and 0.91 in Cronbach's alpha and Raykov's coefficient and between 0.73 and 0.91 in McDonald's omega, suggesting a good level of the instrument's reliability. Furthermore, scores between 0.51 and 0.72 were obtained in AVE, indicating a good level of convergent validity. Moreover, values from 0.50 to 0.57 in HTMT, scores between 0.51 and 0.52 in confirmatory factor analysis, and squared AVE values higher than values of latent correlations among factors provided evidence in support of the instrument's discriminant validity.

### 3.4. Structural equation modeling

The measurement model had an acceptable fit to data: $\chi^2$ ($df = 68$) = 120.250, $p < 0.001$; $\chi^2/df$ = 1.768; CFI = 0.943; TLI = 0.924; SRMR = 0.053; RMSEA = 0.054 (90%CI = 0.038–0.070). Standardized regression weights were between 0.41 and 0.91, with each reaching the statistical significance level ($p < 0.001$). Correlations among factors ranged from −0.28 to 0.36. Altogether, the results underpinned the robustness of the measurement model.

The structural model obtained suitable goodness-of-fit measures: $\chi^2$ ($df = 71$) = 124.802, $p < 0.001$; $\chi^2/df$ = 1.835; CFI = 0.941; TLI = 0.925; SRMR = 0.059; RMSEA = 0.054 (90%CI = 0.038–0.069). Fig. 2 shows that, after controlling for gender (β = −0.08, $p$ = 0.160), autonomy (β = 0.15, $p$ = 0.004), competence (β = 0.27, $p < 0.001$), and relatedness (β = 0.10, $p$ = 0.046), satisfaction positively and significantly predicted ACS. The model accounted for 20% of the variance.

### 3.5. Descriptive statistics and latent mean differences by gender

Table 3 shows that every target variable obtained mean values higher than the mid-point of the measurement scale. After confirming the strong invariance assumption, the results showed that while boys and girls did not significantly differ in autonomy, competence, and relatedness satisfaction, girls were significantly higher than boys in ACS (see Table 4).

## 4. Discussion

The objective of this research was to adapt the BPNS-ACS to the Swedish context of ACS and to provide validity and reliability evidence for the BPNS-ACS(SWE) using a sample of children. The results from this research gather evidence in support of the BPNS-ACS (SWE) as a valid and reliable measure of the children's experiences of autonomy, competence, and relatedness satisfaction in the Swedish context of ACS.

The findings from CFA provided psychometric support for the 12-item three-factor correlated model in the Swedish-specific context of ACS. Indeed, these results showed goodness-of-fit measures similar to the ones reported in the validation study (Burgueño et al., 2020), as well as in the Portuguese and Polish versions (Dzielska et al., 2021; Marques et al., 2021) of the BPNS-ACS. It should be noted that while the Portuguese and Polish versions (Dzielska et al., 2021; Marques et al., 2021) obtained unacceptable values in RMSEA, the Swedish version of the instrument had a good score in RMSEA, suggesting the total absence of misspecifications between the theoretically tested model and the observed data (Kline, 2016). According to the validation study (Burgueño et al., 2020), the examination

**Table 2**
Multigroup analysis of gender invariance.

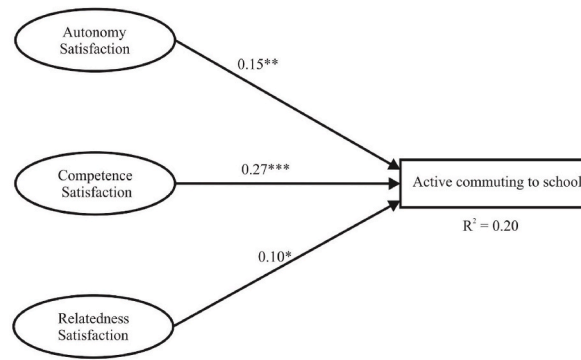|  | $\chi^2$ ($df$) | CFI | RMSEA (90%CI) | Models' comparison | Δ $\chi^2$ (Δ$df$) | ΔCFI | ΔRMSEA |
|---|---|---|---|---|---|---|---|
| 1. Configural invariance | 271.60 (102) | 0.904 | 0.050 (0.048–0.061) | – | – | – | – |
| 2. Weak invariance | 290.85 (111) | 0.898 | 0.048 (0.038–0.059) | 2 *versus* 1 | 19.25 (9)* | −0.006 | −0.002 |
| 3. Strong invariance | 307.02 (123) | 0.896 | 0.045 (0.035–0.056) | 3 *versus* 2 | 16.17 (12) | −0.002 | −0.003 |
| 4. Strict invariance | 368.80 (135) | 0.886 | 0.051 (0.041–0.061) | 4 *versus* 3 | 61.78 (12)*** | −0.010 | 0.006 |

***p < 0.001, **p < 0.01, *p < 0.05.

**Fig. 2.** Predictive effects of autonomy, competence, and relatedness satisfaction on active commuting to and from school. This model was controlled for gender. Ellipses represent latent variables, while rectangles represent manifest variables. ***$p < 0.001$, **$p < 0.01$, *$p < 0.05$.

**Table 3**
Reliability, convergent validity, and discriminant validity.

|  | α | ω | ρ | AVE | √AVE | 1 | 2 | 3 |
|---|---|---|---|---|---|---|---|---|
| 1 Autonomy satisfaction | 0.80 | 0.80 | 0.81 | 0.56 | 0.74 | – | 0.52 | 0.51 |
| 2 Competence satisfaction | 0.91 | 0.91 | 0.91 | 0.72 | 0.85 | 0.57 | – | 0.52 |
| 3 Relatedness satisfaction | 0.76 | 0.73 | 0.76 | 0.51 | 0.71 | 0.52 | 0.50 | – |

Note. α = Cronbach's alpha; ω = McDonald's omega; ρ = Raykov's composite reliability coefficient; AVE = average variance extracted. The numbers above the diagonal show correlations among latent variables from confirmatory factor analysis. The numbers below the diagonal display the heterotrait-monotrait ratio of correlations.

**Table 4**
Descriptive statistics and latent mean differences by gender.

|  | Total sample |  |  |  | Boys | Girls |  |  |
|---|---|---|---|---|---|---|---|---|
|  | Range | M(SD) | γ₁ | γ₂ | M(SD) | M(SD) | Z-value | p-value |
| Autonomy satisfaction | 1–5 | 4.14 (0.85) | 0.91 | 0.23 | 4.05 (0.84) | 4.23 (0.84) | 1.78 | 0.077 |
| Competence satisfaction | 1–5 | 4.36 (1.05) | 1.89 | 1.64 | 4.27 (1.09) | 4.45 (1.00) | 1.39 | 0.165 |
| Relatedness satisfaction | 1–5 | 4.46 (0.77) | 1.80 | 1.29 | 4.38 (0.72) | 4.54 (0.80) | 1.65 | 0.099 |
| Active commuting to school | 1–10 | 6.88 (4.21) | 0.80 | 1.18 | 6.34 (4.50) | 7.34 (3.87) | 2.03 | 0.043 |

of standardized regression weights revealed acceptable values, indicating that each item was meaningfully representative of the factor intended for measurement. Altogether, the results from CFA added evidence to the SDT assumption on the universality of three basic psychological needs in any life domain, including the Swedish context of ACS.

The multi-group analysis results gathered evidence supporting gender invariance for the BPNS-ACS(SWE), consistent with previous studies on BNPS-ACS (Burgueño et al., 2020; Marques et al., 2021). This evidence allows us to recommend using BPNS-ACS(SWE) to inquire more deeply into the potential differences in the level of autonomy, competence, and relatedness satisfaction between Swedish boys and girls. Particularly, the analysis of latent mean differences by gender found that boys and girls showed similar levels of autonomy, competence, and relatedness satisfaction when they actively commuted to and from school. They contrasted with the results reported in Spanish and Polish young people (Burgueño et al., 2020; Dzielska et al., 2021), revealing that male adolescents were higher in the satisfaction of the three basic psychological needs. A plausible explanation for this is that the potential gender differences in the satisfaction of each need may start in secondary school education (Burgueño et al., 2020) and, therefore, Swedish boys and girls (i.e., primary students) are prone to perceive their autonomy, competence, and relatedness as equally satisfied when they active commute to and from primary school. However, additional research is needed to shed light on the need for satisfaction in active commuting to school, depending on the gender and age of commuters.

The findings of the AVE estimations met evidence endorsing the BPNS-ACS(SWE) convergent validity, consistent with Burgueño et al. (2020) and Marques et al. (2021) and in contrast to Dzielska et al. (2021), who reported a marginal score in autonomy satisfaction. Our results entail that the content of items comprising each factor well captured the psychological experiences defining the satisfaction of each basic psychological need when Swedish children actively commute to and from primary school. Moreover, the analysis of latent correlations and HTMT in conjunction with the Fornell and Larcker (1981) criterion provided evidence for the discriminant validity of BPNS-ACS(SWE). Furthermore, values in terms of latent correlations and HTMT were similar to those from the validation study (Burgueño et al., 2020), whereas, to our knowledge, this is the first to add the Fornell and Larcker (1981) criterion to the study of the BPNS-ACS discriminant validity. These findings underscore that Swedish children can clearly differ between autonomy, competence, and relatedness satisfaction for active travels to school. Concerning the instrument's reliability, satisfactory scores

were found in Cronbach's alpha, McDonald's omega, and Raykov's coefficient in each of the three basic psychological needs. These values are in line with the values reported in previous studies (Burgueño et al., 2020; Marques et al., 2021).

The results from SEM gathered criterion validity evidence for the BPNS-ACS(SWE) among Swedish children. These findings are consistent with the hypotheses proposed in this research and with previous research on active commuting (Burgueño et al., 2020, 2022; Zaragoza et al., 2020), such that the children's perception of autonomy, competence, and relatedness satisfaction positively predicted their ACS behavior. This may be because children tended to actively commute to and from school when they perceived opportunities for choice of the specific active mode of active school commuting that best meets their preferences and needs (autonomy satisfaction), felt comfortable with those accompanying them to school (relatedness satisfaction), and when they mainly felt skilled and had developed the physical and mental resources necessary to succeed in their active commuting to and from school (competence satisfaction). Further, competence satisfaction was underscored to have the highest predictive effect on ACS, akin to Burgueño et al.'s (2020) study. This finding suggests the importance for children to perceive their competence as satisfied in their active travels to school, given that it would be strongly linked to the inherent pleasure of personal achievement and the natural tendency of every person to feel competence when successfully undertaking the desired behavior (Ryan et al., 2021). The competence to active commuting is acquired by practicing this behavior, indicating the relevance of implementing interventions to encourage children to actively commute to school.

## 5. Implications for practice

The Swedish version of the BPNS-ACS(SWE) enables us to understand the role that needs satisfaction could have on the development and maintenance of ACS among Swedish children. Specifically, the instrument may be used to analyze changes in children's experiences of autonomy, competence, and relatedness satisfaction in their active travel to school in a single academic year, as well as to examine how autonomy, competence, and relatedness satisfaction may vary throughout the different stages of the life (i.e., childhood, adolescence, or adulthood) in the Swedish context. In addition, the instrument opens the way for the international comparison of the role that autonomy, competence and relatedness satisfaction could play in ACS behavior among children. Up to today, the growing basis of research suggests that competence satisfaction was the stronger predictor of ACS among European students, fact that could be different in children from other regions of the world. On the other hand, this instrument will also allow different social agents (e.g., teachers, families) involved in ACS to more accurately identify those children who are not autonomous enough, lack the skills necessary to active commuting, or feel poorly integrated with their peers in active commuting school. Furthermore, the results from SEM suggest the development of supportive strategies for autonomy, competence, and relatedness satisfaction to promote ACS in children. Indeed, need satisfaction for ACS in children and, especially, competence satisfaction would improve the rates of ACS behavior. Finally, the BPNS-ACS(SWE) could also be used to assess the effects of school-based interventions on need satisfaction for active commuting to school. It is essential to measure the main outcomes of interventions, and questionnaires like BPNS-ACS(SWE) are important tools in this process.

## 6. Limitations

The results of this research gathered support for the credibility of the psychometric properties of the BPNS-ACS(SWE) in children; however, as instrument development constitutes a continuous process over time, further research is needed to address the limitations found in this study. The first limitation has been the use of a purposive sample which has not allowed us to generalize the obtained results to the general population. Additional research is required to replicate the three-factor correlated model in Swedish samples with more heterogenous characteristics, such as other age groups (e.g., adolescents or young adults) or geographic areas such as suburb or rural areas as they have different barriers and facilitators to ACS behavior than urban areas (Molina-García et al., 2020). A second limitation has been the adoption of a cross-sectional design that has made it impossible to ascertain causal-effect relationships between autonomy, competence, relatedness satisfaction, and ACS behavior. There is a need for longitudinal and experimental research to examine the impact of children's perceptions of need satisfaction on their ACS behavior.

## 7. Conclusions

The results of the present research underscore that the BPNS-ACS(SWE) is a valid and reliable instrument to measure the children's perception of autonomy, competence, and relatedness satisfaction in the Swedish context of ACS. The instrument has allowed us to gather evidence suggesting that need satisfaction could benefit ACS among children. Thus, our results underline the importance of considering autonomy, competence, and relatedness satisfaction as key determinants of ACS behavior at the individual level when designing and evaluating ACS interventions.

## Author contributions

PC: Conceptualization, Validation. A-KL: Conceptualization, Data curation, Investigation, Writing - review & editing. LN: Data curation, Validation, Writing - review & editing. RB: Formal analysis, Methodology, Visualization, Roles/Writing - original draft, Writing - review & editing. SR: Conceptualization, Investigation, Project administration, Writing - review & editing. All authors have read and agreed to the published version of the manuscript.

## Funding

## Declaration of competing interest

We the undersigned declare that this manuscript is original, has not been published before and is not currently being considered for publication elsewhere.

We confirm that the manuscript has been read and approved by all named authors and that there are no other persons who satisfied the criteria for authorship but are not listed. We further confirm that the order of authors listed in the manuscript has been approved by all of us.

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## Acknowledgments

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