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Assessment of psychological, social cognitive and perceived environmental influences on children's active transport to school☆

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ABSTRACT

Introduction: In recent years, there has been growing interest in studies integrating social cognitive and environmental variables as predictors of active transport to school (ATS). However, a theoretical model of associations between children's ATS and these variables has not been well established. The aims of this study were (1) to develop and test a model which conceptualized relationships between children's ATS and psychological, social cognitive and perceived environments; and (2) to assess direct effects among these variables.

Methods: Data were drawn from the ProATs, a cross-sectional study conducted with 1189 children aged 9–12 years from 11 primary schools in Huesca, Spain between January and June 2018. A child self-reported questionnaire was used to measure sociodemographic characteristics (age, sex), school travel mode (ATS: walking, cycling; non-ATS: by car, by motorcycle, by bus), and social cognitive and perceived environments. The social cognitive environment was measured based on four constructs of the theory of planned behavior (intention, attitude, social norm, perceived behavioural control), and three constructs of the basic psychological needs (autonomy, competence, relatedness) in the self-determination theory. The perceived environment was assessed through the security and accessibility of neighborhood environmental barriers to ATS. A structural equation modelling technique was utilised to examine direct effects of social cognitive and perceived environments on ATS.

Results: The model achieved acceptable fit, explaining 48% of the variance of children's ATS. Perceived behavioural control was the strongest predictor of intention, and influenced by autonomy, competence and the perceived environment.

Conclusions: Social cognitive and perceived environments played important roles in predicting children's ATS. Future interventions might consider strategies to increase perceptions of autonomy, competence and behavioural control along with strategies aimed to foster more positive perceptions of the built environment.

☆ All authors provided critical edits and revisions to the paper and have reviewed and approved the final version of the paper.

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1. Introduction

Health benefits of physical activity (PA) (e.g. favourable associations with cardiometabolic health, cardiorespiratory and muscular fitness, body composition, self-efficacy and self-concept, as well as reduced risk of diabetes, breast and colon cancers) are unquestionable (Department of Health and Human Services, 2018; Warburton and Bredin, 2017). Despite these benefits, more than 60% of children have not achieved physical activity (PA) recommendations globally (Aubert et al., 2018). According to Spain's 2018 PA Report Card for Children and Youth, the percentage of children aged 3–14 years who met the recommendation of at least 60 min of daily moderate-to-vigorous PA was fairly low (34.2% for boys and 26.9% for girls) (Román-Viñas et al., 2018).

Walking and cycling, the most common forms of active transport to school (ATS), can contribute to daily PA as part of a regular routine as well as other physical, mental and social benefits (Ikeda et al., 2018a; Sun et al., 2015; Larouche et al., 2014). Most recently, the World Health Organization has promoted walking and cycling as one of the priorities in their action plan (World Health Organization (WHO), 2018). Nevertheless, rates of these behaviors have declined or been low in many countries including Spain over the last decade (Rothman et al., 2018; Chillón et al., 2013). Given that ATS is influenced by complex interactions of multiple factors at individual, social and environmental levels (e.g., socio-ecological models) (Ikeda et al., 2019; Mandic et al., 2017), it is critical to obtain insights about these influences to develop effective interventions for children.

Different theoretical models have been developed to understand correlates of ATS including socio-ecological models and social cognitive theories (Lu et al., 2014; Sniehotta, 2009). The Theory of Planned Behavior (TPB), which is a widespread socio-psychological model for the prediction of planned behavior, and is a well-supported theoretical framework applied to analyze attitudes and behavior of children and youth, and has been widely used to explain the mechanism of ATS (e.g. Stark et al., 2018; Abrahamse et al., 2009). The TPB posits that an individual's intention is the most proximal predictor of a health-related behavior (e.g., ATS) and mediates the effect of three belief-based perceptions on the behavior: attitudes, subjective norm, and perceived behavioral control (PBC) (Ajzen, 1991). Intention, attitude and PBC were the most important factors influencing the decision-making of active transport in developing countries (Ding et al., 2017). Subjective norm, despite its positive effect, has a weaker predictive effect on walking and cycling than the other TPB constructs (Darker et al., 2010). It is arguable that the TPB is exclusively based on three predictors (i.e., attitude, subjective norm, PBC), which may not sufficiently explain the variance of behaviour (Hagger, 2010; Sniehotta et al., 2014). Therefore, some researchers have integrated other psychological variables (e.g., psychological needs) into TPB to develop a more comprehensive theoretical model (Hagger and Chatzisarantis, 2016).

The integration of an 'organismic' perspective (i.e., self-determination theory (SDT) can explain why individuals form attitudes, subjective norms, PBC and intentions over the behavior (Ajzen and Madden, 1986). The SDT postulates (Ryan and Deci, 2000) that the satisfaction of basic psychological needs autonomy (the need to feel ownership of one's behavior), competence (the need to produce desired outcomes and to experience mastery), and relatedness (the need to feel connected to others), directly leads to improving psychological wellbeing, and indirectly increasing positive behavioral consequences such as interest, attitude or intention (Vallerand and Losier, 1999). The SDT has been commonly used for PA interventions, but there is little research examining basic psychological

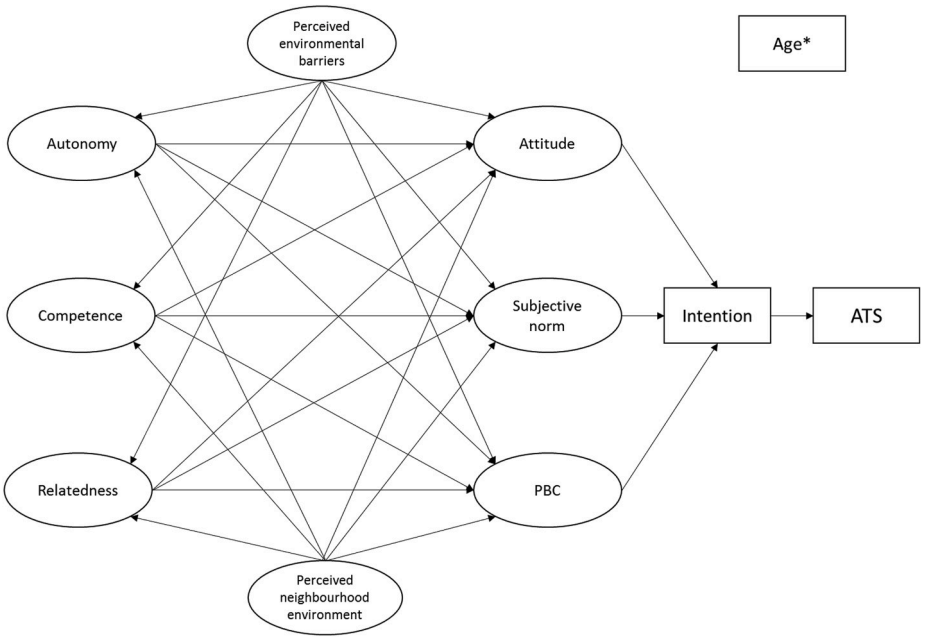

Fig. 1. A hypothesized model of associations between children's ATS psychological, social cognitive and perceived environmental factors. A circle means a latent variable and a square indicates an item. ATS = active transport to school, PBC = perceived behavioural control.
*All latent variables and items were regressed on age.

needs (BPNs), autonomy, competence, and relatedness in relation to ATS. Given that previous research proposed relationships between SDT and TPB constructs (Hagger and Chatzisarantis, 2009), it may be warranted to develop a model to understand the mechanism of ATS by integrating TPB and BPNs constructs (Silva et al., 2014; Kinnafick et al., 2014). In addition to psychological and cognitive factors, it is important to consider environmental factors which can explain the context-specific influences of ATS (Sallis et al., 2006). The choice of active transport modes may result from direct or indirect influences of environmental factors and may be mediated by individual cognitive factors (Arvidsson et al., 2012).

Some studies have developed a theoretical model combining TPB and environmental (perceived or objective) variables to explain ATS (Schölmerich and Kawachi, 2016; Wendel-Vos et al., 2007); other studies found that social cognitive and environmental variables were associated with ATS (Molina-García et al., 2019; de Geus et al., 2019). Findings demonstrated the importance of both 'perceived' and 'objective' measurement of the environmental variables (Ding et al., 2011), where different associations were found between the objective and perceived measures of the same environmental attribute (Van Acker et al., 2013).

While some studies have found a negative influence of age (Aarts et al., 2013; Wilson et al., 2010), others studies found that the propensity for choosing active modes of transport increases with age (Ikeda et al., 2019; Su et al., 2013). The effect of age could be restricted to a certain age range, being only significant for children between 5 and 14 years (Hatamzadeh et al., 2017). Notwithstanding the evidence, it seems necessary to consider age as an influence factor to understand ATS.

To our knowledge, no studies have developed and tested a model which comprehensively integrated psychological and social cognitive constructs (i.e., TPB, BPNs) and perceived environmental factors to explain children's ATS. As with a recent study by Ikeda et al. (2019), this study proposed a new model to explore the aforementioned relationships between children's ATS, psychological and social cognitive constructs (i.e., TPB, BPNs) and perceived environmental factors using structural equation modelling (see Fig. 1). The aims of this study were (1) to develop and test a model which conceptualized relationships between children's ATS psychological needs, social cognitive and perceived environments factors; and (2) to assess effects of psychological, social cognitive (i.e., TPB, BPNs) and perceived environments (i.e., neigbourhood environment and environmental barriers) on children's ATS using structural equation

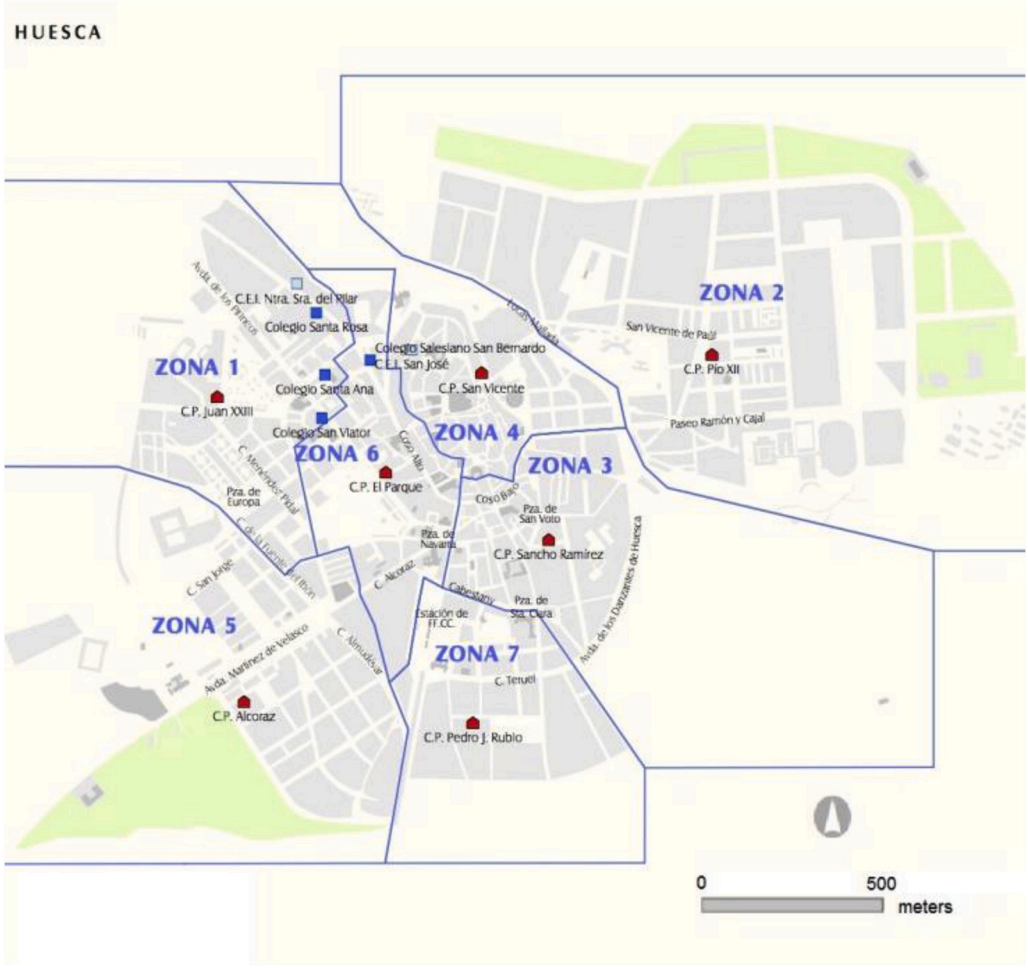

Fig. 2. Schools' spatial distribution. Red (public schools), blue (private schools) spots. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

modelling. We hypothesized that (1) children's attitudes, social norms and PBC would be directly associated with their intentions, and subsequently ATS; (2) children's BPNs would have a direct effect on their attitudes, social norms and PBC; (3) children's perceived environments would influence their attitudes, social norms, PBCs and BPNs; and (4) children's attitude, social norms, PBC, BPNs and perceived environments would contribute to explaining the variance of their intentions and ATS.

2. Material and methods

2.1. Study design, setting and participants

Promote Active Transport to School (Proats) is a cross-sectional study conducted in Huesca, Spain, aimed to increase the prevalence of using active modes of transport to school among children.

The study was conducted in Huesca, a mid-sized city placed in the north-east of Spain. This city has a total population of 52,399 inhabitants and an urban area of 6.75 km^2 (4,21 km^2 without industrial area), with a population density of 7763 inhabitants/km^2 (National Institute of Statistic, 2018).

Children aged 9–12 years (grades 4–6) from 12 primary schools (Fig. 2) in Huesca were invited to participate in the study. Only one school declined their participation. 1560 children were asked to collaborate in the study. Parents were informed about the study, and their written consent was provided for their children to participate in the study. Overall, 1263 parents signed consent (80.96% participation rate). Data were collected between January and June 2018 using a Spanish-version paper-and-pencil self-questionnaire to measure children's mode of transport to school, TPB and BPNs constructs, and environmental perceptions. After excluding incomplete or invalid children's questionnaires and all children who live outside of the city (i.e., households located >4.5 km from child's school) a sample of 1189 children mean age of 10.53 (SD = 0.90) years, (51.1% girls) was included in analyses. Ethical approval to conduct the study was granted by the Ethics Committee on Clinical Research of Aragon region (Spain).

2.2. Measures

A self-reported questionnaire was used to measure the following six sections: 1) sociodemographic characteristics, 2) school travel mode, 3) TPB (i.e., attitudes, social norm, PBC, intention to ATS), 4) BPNs (i.e., autonomy, competence, relatedness), 5) perceived neighborhood environments, and 6) perceived environmental barriers.

2.2.1. Sociodemographic characteristics and school travel mode

Children reported their age and sex. The P.A.C.O (*Pedalea y Anda al Colegio*) questionnaire (http://profith.ugr.es/paco) (Chillón et al., 2017), was used for measuring the modes of commuting to and from school. The usual mode of commuting to and from school was analyzed using the following question: "*How do you usually go to and from school?*". Participants were asked to select one of the six response options: walking, cycling, by car, by motorcycle, or by bus. The responses were categorized as ATS (i.e. walking or cycling) or non-ATS (i.e. by car, by motorcycle or by bus) (Chillón et al., 2017).

2.2.2. Theory of planned behavior

A questionnaire to measure the TPB constructs (i.e., attitude, subject norm, PBC and intention) was developed based on the guidelines provided by Fishbein and Ajzen (2011) and previous studies on ATS in children (Murtagh et al., 2012).

Attitude was measured by three items consisting of one affective component item (i.e. "For me to walk or cycle to school regularly could be unpleasant/pleasant."), and two instrumental component items (i.e. "For me to walk or cycle to school regularly could be bad or good."; "For me to walk or cycle to school regularly could be/useful or useless.") (Elliott and Thomson, 2010). *Subjective norm* was evaluated using three items (i.e. "My father or mother/my friends/my teachers tell me that I should go on foot or by bike to the school."). *PBC* was measured using three items (e.g., "I could go to the school on foot or by bike everyday if I want."). *Attitude* (α = 0.97), *subjective* norm (α = 0.90) and *PBC* (α = 0.92) showed good internal consistency reliability. *Intention* was measured using one item (i.e., "I want to walk or bike to school every day."). Participants reported their level of agreement using a five-point Likert scale (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree).

2.2.3. Self-determination theory: basic psychological needs

Nine items of the BPNs in exercise scale were utilised to measure *autonomy* (three items: e.g., "I can choose how I can go to school."), *competence* (three items: e.g., "I am able enough to go on foot to school without problems.") and *relatedness* (three items: e.g., "I feel very comfortable with those who go to school with me") (Moreno et al., 2008; Vlachopoulos and Michailidou, 2006). Participants reported their level of agreement using a five-point Likert scale. Internal consistency reliability was acceptable in all constructs (*autonomy*: α = 0.67, *competence*: α = 0.82 and *relatedness*: α = 0.84).

2.2.4. Perceived neighborhood environment

A Spanish short-version of the adapted ALPHA environmental questionnaire was used to measure perceived neighborhood environment (Spittaels et al., 2010; García-Cervantes et al., 2014). A neighborhood was defined as 'the area around a participant's home that he/she could walk in 10–15 min, approximately 1.5 km' (García-Cervantes et al., 2014; Spittaels et al., 2010). Participants were asked about their perception of security (i.e., "Walking is dangerous due to the level of crime.") and accessibility (i.e., "At home I have small sport equipment such as balls, rackets, etc.") in their neighborhood using a four-point Likert scale (1 = strongly disagree, 2 =

disagree, 3 = agree, 4 = strongly agree) (α = 0.90).

2.2.5. Perceived environmental barriers

Three items of the BATACE (Barriers to Active Transport to Educational Centres) scale were used to measure the perception of environmental barriers to ATS (e.g., "For me it is difficult to walk to school because other children do not go on foot") (Molina-García et al., 2016). A four-point Likert scale was used to measure the level of agreement (α = 0.99).

2.3. Statistical analysis

Descriptive statistics were performed for the frequency of ATS and relevant sociodemographic characteristics such as sex, and the mean and standard deviation of age and social cognitive and psychological (i.e., TPB and BPNs constructs) and perceived environmental (i.e. neighborhood environment, environmental barriers) variables.

A two-step modelling approach (i.e., measurement and structural models) was undertaken (Anderson and Gerbing, 1988). First, the measurement model involved a confirmatory factor analysis to test the construct validity of latent variables (i.e., *attitude*, *social norm*, *PBC*, *autonomy*, *competence*, *relatedness*, *perceived neighborhood environments*, *perceived environmental barriers*). Items were loaded only on the corresponding latent variable. Error terms were not free to correlate, and the factor loading of one item was fixed at one to define the scale. The reliability of latent variables was determined using a Cronbach's alpha coefficient (with an acceptable level above 0.7).

Second, the hypothesized model (Fig. 1) was tested using structural equation modelling (i.e., structural model). ATS was regressed on intention. Intention was regressed on TPB variables, which were at the same time regressed on BPNs; in turn BPNs were regressed on perceived environment variables. Each endogenous variable was regressed on age as a control variable. Maximum likelihood parameter estimates with standard errors and chi-square test statistics was used to derive parameters estimates. All structural paths and variances of exogenous latent variables were automatically fixed at one. Five model fit indices were used in both measurement and structural models to define 'good' models (Bollen, 1989): Chi-square (X^2), the Comparative Fit Index (CFI; >0.90), the Tucker Lewis Index (TLI; >0.90), the Root Mean Square Error of Approximation (RMSEA; >0.08) and the Standardised Root-Mean-Square Residual (SRMR; >0.05). All statistical analyses were conducted with MPlus version 6.1.

3. Results

The options kept in this study were walking (74%), cycling (0.9%). All the other answers had to do with inactive modes of travel (car, motorcycle and public transports 25.1%). Descriptive statistics (means, standard deviations, standardised estimates and standard error) of all items which compose latent variables were presented in Table 1. Just over two thirds (67.1%) of the total sample (10.61 ±

Table 1
Descriptive statistics of latent variables and items.

Latent variable	Item	Mean	Standard deviation	Factor loadings	Standard error
TPB: *Attitude*	For me to walk or cycle to school regularly could be unpleasant/pleasant	3.68	1.14	.57	.03
	For me to walk or cycle to school regularly could be good/bad	3.95	.96	.87	.03
	For me to walk or cycle to school regularly could be useful/useless.	4.33	1.01	.61	.03
TPB: *Subjective norm*	I usually go on foot to the school with my parents	2.38	1.62	.32	.05
	My parents usually go on to foot to their workplace	3.01	1.65	.76	.11
TPB: *Perceived behavioural control*	I have time to go on foot to the school every day if I wanted	3.98	1.34	.72	.03
	I live in a place that allows me to go on foot to the school every day if I wanted	4.02	1.32	.76	.03
BPN: *Autonomy*	I go to school using my preferred mode	3.71	1.42	.69	.04
	I can choose how I can go to school	3.30	1.41	.74	.04
BPN: *Competence*	I am able enough to go on foot to the school without problems	4.46	.97	.67	.04
	I am skilled to go to school on foot	4.43	.94	.80	.03
	I feel capable to go on foot to school	4.48	.95	.79	.03
BPN: *Relatedness*	I feel at home with those who go to the school with me	4.15	.94	.48	.05
	I feel that I can chat relax with those who go to the school with me	4.44	.92	.69	.04
	I feel very comfortable with those who go to the school with me	4.47	.83	.65	.05
Perceived neighborhood environments	Security: Walking is dangerous due to the level of crime	1.22	.41	.62	.06
	Accessibility: At home I have small sport stuffs such as balls, rackets, etc.	1.18	.32	.50	.05
Perceived environmental barriers	For me it is difficult to go walking to school because other children do not go on foot	1.49	.96	.71	.04
	For me it is difficult to go walking to school because my bag is too heavy	1.32	.76	.52	.05
	For me it is difficult to walk to school because it is more convenient for someone to drive me there	1.54	.96	.54	.04

BPN = Basic psychological need, TPB = Theory of planned behaviour.

0.93 years old) used active modes of transport to school. The mean and standard deviation of children's intention to ATS showed 4.01 ± 1.27 points (in a five-point Likert scale).

In the measurement model, one item each from subjective norm, PBC and autonomy was removed due to their low factor loadings (<0.50), resulting in acceptable Cronbach's alpha levels in all latent variables ($\alpha > 0.70$; George and Mallery, 1995). This modified model provided good fit indices (χ^2 (142) = 206.470, $p < .001$; χ^2/df. = 1.45; RMSEA = 0.020 (LI 90 = 0.013; LS 90 = 0.025); CFI = 0.98; TLI = 0.97; SRMR = 0.026). All factor loadings (λ) were significant ($t > 1.96$).

Fig. 3 presents significant direct relationships among the variables in the structural model ($p < .05$). The modified model provided a good fit to the data ($\chi^2(193) = 518.774$, $p < .001$; χ^2/df. = 2.68; RMSEA = 0.038 (LI 90 = 0.0.34; LS 90 = 0.042); CFI = 0.93; TLI = 0.91; SRMR = 0.043), explaining 48% and 47% of the variance of children's ATS and intention, respectively. ATS was positively associated with intention to commute actively to school ($\beta = 0.13$, $p < .001$) and negatively with age ($\beta = -0.67$, $p < .01$). Intention, at the same time, was positively related to PBC ($\beta = 0.69$, $p < .01$). In turn, PBC was positively related to autonomy ($\beta = 0.29$, $p < .001$) and competence ($\beta = 0.34$, $p < .001$), but negatively to perceived environmental barriers (β = -0.40, $p < .001$).

4. Discussion

This study aimed to develop and test a model which conceptualized relationships between children's ATS, psychological, social cognitive and perceived environmental variables, and to assess effects of these variables on children's ATS using structural equation modelling. Social cognitive and perceived environmental variables in modified model explained 48% and 47% of variance of ATS and intention, respectively.

In line with the previous studies, intention was positively associated with ATS (Trapp et al., 2011; Lemieux and Godin, 2009; Armitage and Conner, 2001). The current findings also demonstrated that intention was the most strongly predicted by PBC, which was, in turn, significantly predicted by autonomy, competence and perceived environmental barriers. A few previous studies also reported that PBC was the strongest predictor of children's intentions to actively commute to school (Lemieux and Godin, 2009; Eves et al., 2003). Although the lack of statistically significant associations between attitudes, subjective norms and intentions is somewhat surprising, Ajzen (1991) and Armitage and Conner (2001), have noted some inconsistencies regarding the expected contribution of subjective norms to intentions. Furthermore, the current findings are consistent with previous work by Murtagh et al. (2012), who reported that neither attitudes nor subjective norms predicted intentions to actively commute to school.

For some behaviors, the effect of PBC could overshadow the effect of attitudes and subjective norms on intention. Children's intention and their behaviour at this age, could be more influenced by internal considerations (e.g. PBC) than external influences of other people's opinions (e.g. attitude or subjective norm). Although children's PBC may influence the choice of active transport modes (Carver et al., 2013), parents often govern their children's transport mode decision (Carver et al., 2013). The lack of influence of subjective norm could imply that this construct might have captured only limited perceived social pressure from others, meaning an individual's perception of how others typically behave (i.e., descriptive norm component) might have been overlooked (Ajzen, 1991).

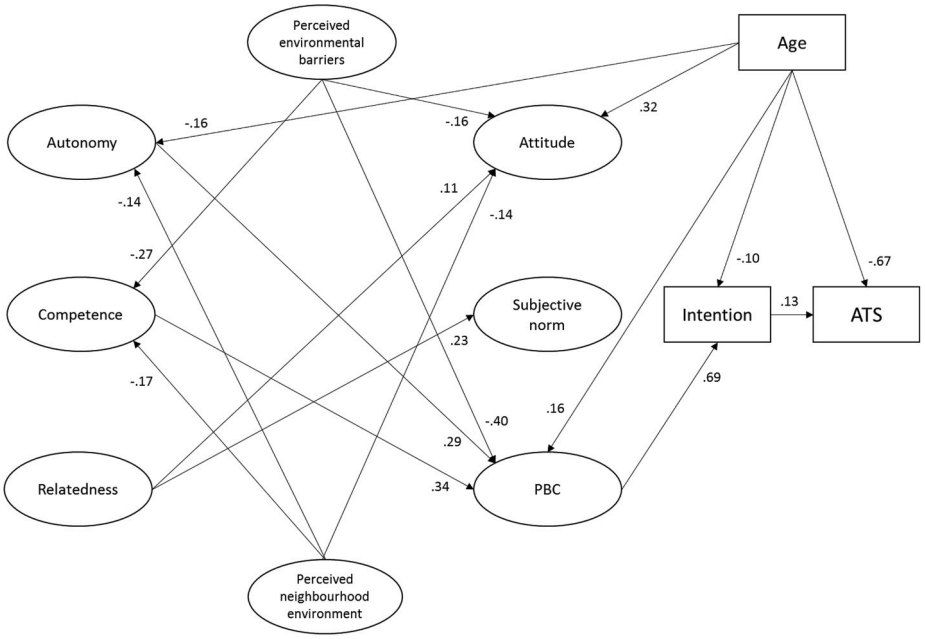

Fig. 3. Standardised estimated coefficients of associations between children's ATS and social cognitive, psychological and perceived environmental variables using structural equation modelling. Only significant pathways ($p < .05$) are presented to facilitate readers comprehension. A circle means a latent variable and a square indicates an item. ATS = active transport to school, PBC = perceived behavioural control.

Consistent with the current findings, several reviews on children's PA using TPB have demonstrated inconsistent contribution of children's attitudes to their intentions (e.g., Nelson et al., 2009; Scott et al., 2007). This study only considered the affective component of attitudes (e.g., feelings about ATS) but other components such as cognitive (e.g., safe, fast, convenient) or behavioural (e.g., elements related to the pollution, possibility of sharing with others). Cognitive, affective and behavioral attitudes towards ATS are likely to be associated with intentions to actively commute to school ATS (García et al., 2019). Further, it is likely that different behaviors such as walking and cycling can have unique structures of TPB (Adams et al., 2013; Abrahamse et al., 2009). In terms of walking and cycling for leisure and transport, Eves et al. (2003) reported that intentions of walking were only predicted by PBC; whereas intentions of cycling by attitude and PBC. It is important for studies on transport behavior to consider active modes of transport (i.e., cycling and walking) separately because these modes may be perceived differently by people.

It is evident that BPNs were associated with social cognitive theories including TPB (e.g., attitude, PBC, intention) in the area of PA (Hagger et al., 2006) and ATS (Silva et al., 2014). This study also showed that the constructs of BPNs specifically autonomy and competence were significantly related to PBC, meaning children who were highly satisfied with their need for autonomy and competence might have high control over performing ATS. It might also indicate that BPNs had indirect influences on intention (Hagger et al., 2002; Hagger et al., 2006; Standage et al., 2003).

There is a lack of understanding on the effects of perceived environments on social cognitive pathways when predicting ATS. In accord with previous studies (https://www.sciencedirect.com/science/article/pii/S136984781830679X, Panter and Ogilvie, 2015; Rhodes et al., 2007; Rhodes et al., 2006), the current findings showed that perceived neighborhood environments (i.e. security and accessibility) and perceived environmental barriers to ATS (i.e., environment and safety barriers) were related to TPB (i.e. attitude, PBC) and BPNs (i.e., autonomy, competence) constructs. In line with our results, other studies have shown that individuals with a lower perception of accessibility to PA or unsafe neighborhood perceptions may negatively influence on their perceptions of autonomy, competence, attitudes or PBC (Dowda et al., 2009). The more resources and fewer obstacles individuals perceive, the greater PBC and stronger intentions to perform behaviors they have (Dawson et al., 2001; Kimiecik, 1992). In addition to the direct influence of the perceived environments on ATS (Molina-García et al., 2017), it is possible that these factors could indirectly influence intention and consequently ATS through PBC. In our study perceived environmental barriers was the strongest predictor of PBC (which in turn, was the strongest predictor of intention), suggesting that both skills and abilities to improve ATS behavior and a supportive environment may be required in future interventions. Nevertheless, other environmental components should be incorporated into future studies (i.e., the neighborhood features around the home, the route between home and school, and the environment of the school itself), as possible influences on ATS (Moudon and Lee, 2003).

Age was another predictor of children's intentions and ATS. Consistent with previous research (Silva et al., 2011; Chillón et al., 2009; Butler et al., 2007), an inverse relationship between age and ATS was found in the current study. However, this finding should be cautiously interpreted because children at this age (i.e., 9–12 years) can be influenced by other factors such as maturation, experience and cognitive processing capacity which are potentially associated with their intentions and ATS (Tabibi et al., 2012). Various strategies for different age groups may be required to promote ATS (Hatamzadeh et al., 2017). It may be surprising that the distance from home to school was not addressed in this study. Distance to school is the strongest and most consistently demonstrated determinant of ATS internationally (Curtis et al., 2015; Rothman et al., 2018). However, in our studio the 81% of the subjects live less than 1.5 km away from home to school. This is the reason why this variable has not been considered in this study.

4.1. Strengths and limitations

One of the major strengths of this study was the use of a robust structural equation modelling technique to assess the complex interrelationships among children's ATS and social cognitive and perceived environmental factors. This technique allowed the simultaneous integration of psychological, social cognitive and perceived environmental variables to explain children's intentions and ATS. Furthermore, this study included a large representative sample from one mid-size city (11 out of 12 schools from the city) which increased the precision and representativeness of the results in this specific context. Despite these strengths, the current findings cannot be generalized to other urban or rural areas in Spain, or abroad as the participants came from one particular city in Spain. The hypothesized model was tested in a specific environmental context, and contextual differences of children's responses may exist due to their cultural and social background (Laroche et al., 2002). Further empirical investigation will be required to generalize the hypothesized model to other contexts. Causal inferences cannot be made due to the cross-sectional study design. The child self-reported questionnaire might be vulnerable to cognitive, affective and self-presentational biases, and result in under- or overestimating their behavior (Montoye et al., 1996). Notwithstanding, measures of school travel mode and the perceived environment used in this study have been validated in previous studies in Spanish youth. Some results of this study should be considered with caution as some categories (e.g., accessibility) of latent variables are built with just only one item. Future studies should be conducted to replicate our results. The application of a few perceived neighborhood environment measures (i.e. security, accessibility) might be a limitation. Other perceived and objective environmental variables such as the characteristics of destinations and routes between home and school can be considered in future research (Ikeda et al., 2018b). The effect of biological maturation can be a factor of modifying the patterns of children's PA and ATS but was not measured in the current study. Previous studies showed an inverse association between PA and maturation in boys and girls, particularly in children (Davison et al., 2007; Thompson et al., 2003; Sherar et al., 2007). Finally, another possible limitation could be the data collection schedule (i.e., conducted in January and June). ATS may be less amenable due to temporal factors such as weather and determined predominantly by pre-existing built environment and social variables such as time and convenience (Schlossberg et al., 2006). Nevertheless, in our study, we excluded households located >4.5 km from child's school (i.e. households located outside the urban area of Huesca). Considering this fact and based on Kallio et al. (2016), it is possible that the

homogeneity in distance from school (81% lived within 1.5 km of school), do not introduce any bias in the responses although collection dates are different.

5. Conclusion

Psychological, social cognitive and perceived environmental factors played influential roles on children's ATS. The model tested also demonstrated a complex structure of associations among these factors. Children's autonomy, competence, relatedness, perceived behavioral control as well as perceived environmental barriers were directly and indirectly related to children's intention and ATS. Our findings have some implications for policy makers and transport planners. Internal factors (e.g. PBC) and a supportive environment should be addressed in future interventions to modify the patterns of ATS. Increasing children's ATS requires action on multiple fronts. Environmental and psychological-cognitive interventions must be integrated and operate within the same system. Policymakers should try to understand people's judgements and interpretations of the environment and acknowledge the reciprocal and dynamic relationships between people and places.

Availability of data and material

Data are available for research. Any further inquiries can be directed to the authors.

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Declaration of competing interest

The authors declare no conflict of interest.

CRediT authorship contribution statement

Javier Zaragoza: Writing - original draft, Writing - review & editing, Methodology. **Ana Corral:** Investigation, Data curation. **Erika Ikeda:** Writing - review & editing, Resources. **Enrique García-Bengoechea:** Methodology, Conceptualization. **Alberto Aibar:** Formal analysis, Supervision, Resources.

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