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► **To cite this version:**

Thibaut Derigny, Joseph Gandrieau, Léa Mekkaoui, Clément Llena, Christophe Schnitzler, et al.. “Take a Ride on a Lifelong Journey!” A Physical Literacy School-Based Intervention to Safely Engage Adolescents in Active Transport. *Journal of Teaching in Physical Education*, 2024, pp.1-10. 10.1123/jtpe.2023-0356 . hal-04777823

HAL Id: hal-04777823

<https://hal.science/hal-04777823v1>

Submitted on 12 Nov 2024

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“Take a Ride on a Lifelong Journey!” A Physical Literacy School-Based Intervention to Safely Engage Adolescents in Active Transport

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Purpose: To provide safe and high-quality physical education, this study analyzed a physical literacy school-based intervention on active transport to school. **Method:** A total of 185 pupils (age_{mean} = 11.76 ± 0.52; 46% girls) participated in the intervention. Pupils from test ($n = 110$) and control ($n = 75$) groups completed a survey based on their perceptions of the four dimensions of physical literacy (physical, cognitive, psychological, and social). **Results:** The test group displayed a significantly higher level of overall physical literacy compared with the control group (14.9 vs. 13.4) and also in the specific physical (16.4 vs. 15.3), cognitive (16.0 vs. 12.8), and psychological (15.3 vs. 13.8) dimensions. Boys recorded a significantly higher score than girls (16.7 vs. 14.5), particularly in the test group where girls showed less improvement than boys compared with the control group (+2.78 vs. +1.76). **Discussion/Conclusion:** Physical literacy is a dynamic process, which may be useful to reinforce the importance of incorporating this concept into physical education lesson planning while focusing on gender differences.

Keywords: physical activity, ecological framework, development, questionnaire, mobility

Low levels of physical activity (PA) continue to be recorded in teenagers all around the world (Guthold et al., 2020). For both boys and girls, more than 80% of teenagers do not meet the health recommendation for acceptable PA levels (Bull et al., 2020). One of the most cited barriers for lack of participation in PA is a perceived lack of time (Duffey et al., 2021). Recent research has shown that the most active teenagers are those who take the most opportunities for PA during the day (Derigny et al., 2022). Active transport to and from school (ATS) accounts for a large proportion of these PA opportunities, constituting a major component of the “time equation” for secondary school students (Derigny et al., 2022). Moreover, many teenagers are currently looking for autonomous forms of PA that are not too formally organized (French National Sports Barometer, 2020). Whereas sports clubs impose structured timetables on participants, active transport is free, heralding an increase of 6% in ATS since 2018 in France (Observatoire Nationale de l'Activité Physique et de la Santé [ONAPS], 2023). As walking may be unrealistic and demanding for long journeys, cycling is a better alternative than motorized travel (Chaix et al., 2019).

These forms of ATS are positively associated with better health levels, such as, for example, better cardiorespiratory fitness, reported well-being, and academic performance (Andersen et al., 2009; Borrestad et al., 2012; Lubans et al., 2011; Voss & Sandercock, 2010).

At the same time positive for health, time efficient, and meeting modern teenagers' expectations, ATS appears to be one of the best ways to increase PA participation in contemporary generations (Faulkner et al., 2009; Kek et al., 2019; Mendoza et al., 2011; Pabayo et al., 2012). Widely studied in Oceanic and Spanish school contexts (Rahman et al., 2022; Chillón et al., 2021), research on ATS in occidental countries has mainly focused on reducing pollution and noise in urban environments (De Nazelle et al., 2021; Stappers et al., 2023; Teran-Escobar et al., 2022). The utility of ATS forms still needs to be further explored with respect to understanding PA needs of children, however.

To promote ATS, the French school system has proposed the “How to ride a bike” program (French Ministry of Education, 2019a) with the aim of tripling daily bike journeys from 2024 from 3% to 9% of children (French Ministry of Education, 2019b). This population health goal is currently in progress (a 6% increase has been recorded already, ONAPS, 2023), showing the impact of school-based interventions and the construction of cycling paths in the built environment (Chaix et al., 2019; ONAPS, 2023). However, this type of progress only seems to benefit boys from advantaged socioprofessional backgrounds, those who already have a physically active lifestyle, or those who already benefit from high levels of family support (Bungum et al., 2014; Mitra et al., 2017; Vieille-Marchiset et al., 2019). Moreover, ATS is not without risk for users as the rates of deaths and serious injuries for cyclists have risen to 8% and 20%, respectively, since 2021 (Observatoire Nationale Interministérielle de la Sécurité Routière [ONISR], 2022). These unfortunate events have mainly occurred in urban areas (95%) and among boys (87%), demonstrating the importance of combining educational strategies for daily PA with a safe cycling education program.

Systematic reviews have emphasized the importance of using sound theoretical frameworks for planning school-based


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interventions to have long-term effects on PA (Love et al., 2019; Kettle et al., 2022; Rodrigo-Sanjoaquin et al., 2022). Adopting cycling as an ATS requires the development of strategies capable of generating sustainable behavioral changes. Carl et al. (2022) have shown through a systematic review the effectiveness of interventions that are anchored in the theoretical framework of physical literacy. Considered as a component of quality physical education (PE) by UNESCO (2015), the International Physical Literacy Association (2017) adopts Whitehead's (2010) perspective in defining physical literacy as "the motivation, confidence, physical competence, knowledge and understanding to value and take responsibility for engagement in physical activities for life." The Australian conception highlights the necessary holistic development of people through movement, according to the articulation of physical, cognitive, psychological, and social dimensions (Keegan et al., 2019). Although outcomes of physical literacy interventions remain promising (Carl et al., 2022), adapting the theoretical and philosophical foundations of physical literacy into planned practical interventions remains a complex challenge (Durdin-Myers et al., 2018).

Few interventions combine environmental exploration with a school-based educational strategy, whereas the physical literacy conception proposed by Cairney et al. (2019) places the individual at the core of a multilevel interaction between them (considering their physical, cognitive, social, and psychological dimensions) and their environment. In line with the three philosophical pillars of physical literacy (Whitehead, 2010), developing and enhancing cycling proficiency implies a holistic development of the four dimensions (monism) to move around in a complex space (existentialism), allowing them to identify and exploit environmental affordances (Davids et al., 2008; e.g., interacting with movements of other cyclists, pedestrians, and motorists while controlling their bike) and adapting to all events (phenomenology). In other words, it is essential that ATS education confronts children and adolescents with a variety of environments and tasks so that they can learn to adapt their actions when learning to negotiate situations of increasing uncertainty and complexity (Seifert et al., 2013).

A systematic review of ATS interventions has highlighted that promotional cycling programs currently seek to address some perceived environmental barriers (Chillón et al., 2011): For example, they attempt to teach children to ride safely and confidently, using appropriate hand signals and performing basic bike maintenance (Hooshmand et al., 2014; Wallace and Sutton, 2015). However, these interventions have not articulated the four dimensions of physical literacy as the psychological and social dimensions of behavioral interactions have not been considered. This is also the case for the French program "How to ride a bike" (French Ministry of Education, 2019a) wherein the interventions tend to focus on physical and cognitive dimensions (fundamental motor skills on a bicycle, road safety, and bicycle repairs) and the discovery of the environment (cycle paths). The "How to ride a bike" program does not currently consider the social and psychological dimensions as presupposed in the holistic approach to physical literacy (Carl et al., 2023).

The specificity of cycling education in France has tended to raise similar issues. Vieille-Marchiset et al. (2019) have highlighted the interactions between competence levels and social background of individuals, showing that when girls from low sociocultural backgrounds improve their cycling skills, they may be prevented from using these skills so that they remain under parental control. Thus, there is a need to consider how the contribution of the social and psychological dimensions of human behavior promotes developmental competencies needed to enhance transport safety. This type of learning transfer may be

from "knowing how to ride a bike" in a closed environment (the school playground) to negotiating an open (information-laden) and uncertain environment (cycle paths) on a cycle. The development of informational competences, included in the four dimensions of the Australian conception of physical literacy (e.g., information taking, risk management, perceived motor skills, presence of peers), is essential for this type of knowledge transfer. It has been proposed that girls tend to "lose confidence" (Vieille-Marchiset et al., 2019), and boys may suffer from "overconfidence" (Vallerand and Thill, 1993), which can cause safety problems resulting in accidents (ONISR, 2022). To the best of our knowledge, there have been no studies as yet seeking to examine the outcomes of an ATS education program based on the concept of physical literacy.

The aim of this study was to investigate the effect of a physical literacy school-based intervention on children's perceptions of being able to engage safely and sustainably in ATS. The intervention program analysis involved a comparison between test and control groups, with data examined according to sex differences. The hypothesis is that participants in the test group (those who undertook the cycling intervention program) are more inclined to engage in ATS than those in the control group (those who undertook a traditional PE program) because they have higher awareness and perception of information in the ATS environment, reflected in higher levels in all dimensions of physical literacy.

Methods

Study Design

A secondary school near Paris in France was selected to take part in the study, which involved two distinct topics teaching sequences related to cycling. Nine classes of the first grades participated in the study. Five were randomly selected to participate in the physical literacy school-based intervention with ATS (test group) and the four others benefited from a program of traditional PE lessons (control group). In the test group, pupils were separated into two subgroups during the intervention: The first group developed motor resources on the bike, and the second involved a workshop on road safety, benefits of PA, and undertaking bike repairs. PE teachers included the two teaching sequences in the school curriculum and made them compulsory for all children in the selected grades. The objectives of the teaching sequences were coconstructed between PE teachers and a member of the research team (see Table 1).

The intervention was conceptualized according to the recommendations of Carl et al (2023), seeking to promote the key philosophical underpinnings of physical literacy. These included: (i) monism, founded on the articulation of the four dimensions of physical literacy; (ii) existentialism, emerging from the interaction between the individual and their environment, in this study, enabling the discovery of cycling pathways, trails, and parks around the school (Cairney et al., 2019; Rudd et al., 2020); and (iii) phenomenology, with a cycling course proposed to pupils to help evaluate their progress necessary for validating for capacity to cycle in environments outside the school (the bike challenge; Gandrieau et al., 2023). Test performance was considered successful if the participant could achieve the main goal without recording how they achieved it. The lesson plans were codesigned with the teacher, who adapted the content to the educational level of the participants during the lessons.

To assess the implementation fidelity, a member of the researcher team (Derigny) was present during all cycling lessons. He checked the materials and the teaching in the physical literacy framework during each lesson. A grid was used to assess the

Table 1 Aims of the Active Transport to and From School (ATS) School-Based Intervention, According to the Four Dimensions of Physical Literacy

Physical literacy dimensions		Targeting learning
Physical	Developing motor skills for cyclists	<ul style="list-style-type: none"> - Control the bike's trajectory and maintain balance in different cycling contexts - Change gear, position pedals according to the bike's trajectory - Slalom through gaps varying in width and narrowness, avoiding contact with objects and without using emergency braking - Bike challenge test: validation of the pedaling license and complex control of the bike's trajectory with one hand and in bends - Application of the pedaling license
Cognitive	1. Knowledge of health benefits of physical activity; 2. Technical knowledge of local cycling facilities; 3. Knowledge about bike maintenance	<ul style="list-style-type: none"> - Checking and preparing the bike at the start and end of the lesson - Assembling and repairing the bike - Discovering cycle paths in the local surrounding area - Demonstrating use of the local cycle paths identified - Understanding the positive effects of physical activity on health - Anticipating cycle trajectories - Implementing safety rules to avoid hurting passersby - Perceiving relevant information rapidly and reacting to the actions of passersby without endangering oneself
Psychological	Promoting positive affect in practice	<ul style="list-style-type: none"> - Developing self-knowledge through a "Bike Challenge" assessment - Enjoying cycling, having fun through games, and undertaking collective and/or individual challenges - Experiencing the pleasure of riding in a collective and negotiating uncertain environments - Realizing the project outcomes by engaging in a form of playful cycling activity
Social	Promoting a collective road environment and cycling culture	<ul style="list-style-type: none"> - Raising awareness of the benefits of active transport for the planet (ecology) - Applying safety rules and experimenting with different cycle routes to get to school by bike - Engaging in and promoting the culture of cycling

teaching in the four domains (physical, cognitive, social, and psychological) according to the content of the targeted learning (Table 1). Sometimes, minor modifications were necessary depending on the absence of pupils or weather changes (interventions were planned outside). They did not impact the philosophical construction of the interventions.

Outcomes Measure

Based on the four dimensions of physical literacy, a questionnaire (inspired by that of [Vieille-Marchiset et al., 2019](#)) was created following two steps: (i) identification of categories and (ii) development of a scale measurement. For the first step, the research team (Derigny and Gandrieau) designed the items to assess each physical literacy dimension, with the help of the five PE teachers from the school. Each item was discussed until unanimous consensus was reached on the completeness of the items and their relevance to the knowledge categories and the target population. At the end of this step, the tool consisted of 28 items. The second step was based on these items selection. Three members of the research team (Derigny, Gandrieau, and Schnitzler) designed a scale measurement by a triangulation method ([Lincoln & Guba, 1985](#)). The category scales were verified by the three other members of the research team (Mekkaoui, Llena, and Potdevin) and the five PE teachers from the school. Throughout these two steps, recommendations of Lawshe (1975) were followed to consider the acceptance standard of content validity ratio (≥ 0.99) to assess the content validity ([Haynes et al., 1995](#)).

Immediately following the last lesson, all the pupils from the two groups completed the questionnaire to assess their perceptions

of their own development in each of the physical literacy dimensions. Responses were organized according to a three-level ordinal scale wherein scores were attributed to each perceived level of development, ranging from *not at all competent* (0 points) to *more or less competent* (1 point) to *completely competent* (2 points). The overall scores for each dimension were averaged over 20 points. Thus, the closer the score was to 20, the higher was the perception of development in a physical literacy dimension. Participation in the questionnaire was voluntary for all invited participants. Parents and children were informed of the purpose of the study by signing a consent form stating that they could freely decide not to take part or to withdraw with no consequences from this activity of the teaching sequence.

Statistical Analysis

First, to measure the internal validity of the questionnaire, three steps were undertaken. A factorial analysis was performed to group items into common categories (data reduction with Kaiser–Meyer–Olkin [KMO], Barlett test, uniqueness, and variance explained). The internal consistency of items was analyzed using the Cronbach alpha statistic, requiring an outcome value of $>.7$ to be included in the questionnaire. An analysis of sensitivity was used to explore the variation coefficient and Fergusson delta. The test–retest method using interclass correlation coefficients could not be carried out because the questionnaire was only administered once after the final lesson.

Second, chi-squared tests and Kruskal–Wallis tests were used to detect effects of gender, age, location, and experiences in bike education on the participants included in the group comparison.

A two-way analysis of variance was performed to determine the effect of intervention on each dimension of the questionnaire. Effect size values were determined using the partial eta squared statistic (η_p^2) and their confidence intervals, which were interpreted as follows: $\eta_p^2 = .01$: small; $\eta_p^2 = .06$: medium; and $\eta_p^2 = .14$, large (Cohen, 1988). Between-group differences for the same gender (test vs. control), between-gender differences for the same group (boys vs. girls), and their interactions were analyzed by Tukey post hoc tests.

Statistical analyses were conducted with R software (version 4.2.1). Data on groups, gender, age, and results of the questionnaire were tested for normality, interdependence, and homoscedasticity using the Shapiro–Wilks, Levene, and Jarque–Bera tests. As a normal distribution in the data was observed, mean and *SD* were reported to describe outcomes. For all analyses, the threshold of statistical significance was set at $p < .05$.

Results

Internal Validity of the Perception Development Questionnaire

For the data reduction process, the exploration of the correlation matrix was a preliminary step, which showed that the data were sufficiently reduceable (KMO: 0.88, correct; Barlett's test: $p < .05$). The social dimension was excluded from the questionnaire because the factor saturation revealed that this dimension had no items. During factorization for the three other dimensions, the uniqueness analysis led to the exclusion of five items ($\mu^2 < 0.6$ to be included), indicating that they did not form a strong part of the participant responses that were elicited. One item was not clearly saturated in a dimension and was, therefore, excluded (score < 0.40 in the four dimensions). Within the dimensions, the factorial analysis reduced the number of items from 19 to 13. In the end, combining the items led to a factorization of the questionnaire into three dimensions: physical with four items and 33% of the variance explained, cognitive with five items and 36% of the variance explained, and psychological with four items and 31% of the variance explained.

Next, the sensitivity analysis was carried out on the three dimensions included, revealing coefficients of variation ranging from 15.83 for the physical dimension to 25.91 for the cognitive dimension and 27.04 for the psychological dimension, all considered satisfactory. The Fergusson delta value was appropriate for the physical dimension (0.81) and excellent for the cognitive dimension (0.98) and the psychological dimension (0.99). Finally, the

internal consistency analysis revealed a Cronbach's alpha value greater than .7 for each item in each dimension, leading us to retain all of them (physical: $\alpha = .79$; cognitive: $\alpha = .78$; psychological $\alpha = .71$). Table 2 presents the internal validity data on the perception development questionnaire.

Participants Included

One hundred and eighty-five participants were involved in this intervention study (age_{mean}: 11.76 ± 0.52 years, 86 girls and 99 boys). Participants who did not respond to the questionnaires correctly were excluded ($n = 13$, e.g., responses missing, several responses to the same question). The nonsignificant chi-square and Kruskal–Wallis test outcomes highlighted the homogeneity of the intergroup test ($n = 110$, 54 girls and 56 boys, age_{mean}: 11.72 ± 0.47 years) and control ($n = 75$, 32 girls and 43 boys, age_{mean}: 11.88 ± 0.59 years) according to age, gender, location, and initial level of cycling experience declared before the school-based intervention. However, significant effects were observed in three categories: the test group had more experience in cycling (yes: 96% vs. 87%, $p < .05$), families from the test group were most invested in cycling teaching (76% vs. 48%, $p < .05$), and more participants from the test group had their own bike (80% vs. 49%, $p < .05$). Table 3 presents the descriptive statistics for all included participants.

Perception of Development According to the Physical Literacy School-Based Intervention

Table 4 displays the scores of participants for each dimension according to group and gender breakdowns. For the overall score, results of the analysis of variance highlighted a large group effect, $F(1,181) = 28.73$, $p = .25^{e-08}$, $\eta_p^2 = .14$, and a large gender effect, $F(1,181) = 34.82$, $p = .17^{e-09}$, $\eta_p^2 = .16$. Thus, participants from test group and boys displayed, respectively, higher overall scores than participants from the control group and girls after the intervention (test vs. control: 14.9 vs. 13.4, $p < .05$; boys vs. girls: 16.7 vs. 14.5, $p < .05$).

Group effects are displayed in the three dimensions: physical (16.4 vs. 15.3), $F(1,181) = 5.07$, $p = .26^{e-02}$, $\eta_p^2 = .03$, small; cognitive (16.0 vs. 12.8), $F(1,181) = 50.41$, $p = .59^{e-04}$, $\eta_p^2 = .04$, small; and psychological (15.3 vs. 13.8), $F(1,181) = 7.77$, $p = .28^{e-12}$, $\eta_p^2 = .22$, large, with significantly higher scores reported for participants in the test group than in the control group. Gender effects are also shown in the three dimensions, with a significantly higher scores for boys compared with girls in physical (18.4 vs.

Table 2 Perceived Development Questionnaire

Physical literacy dimension	Bike specificity	Exploratory factorial analysis			Sensitivity		Internal consistency	Example of questions
		Item before	Item after	Variance explained	Variation coefficient	Fergusson delta	Cronbach alpha	
Physical	Motor skills	10	4	33%	15.83	0.81	.79 (.74; .84)	<i>I am able to move the bike with one hand</i>
Cognitive	Knowledge of traffic regulations and repairs	5	5	36%	25.91	0.98	.78 (.73; .83)	<i>I am able to change a wheel</i>
Psychological	Mobility in an uncertain environment	7	4	31%	27.04	0.99	.71 (.64; .78)	<i>I feel comfortable cycling in my neighborhood</i>
Social	Relating to others	6	0	—	—	—	—	<i>I cycle with friends</i>

Note. These examples of questions can be found in the questionnaire.

Table 3 Descriptive Statistics Presented for the Whole Sample and the Test and Control Groups

	Whole sample	Test group	Control group	Group effect		
				<i>p</i>	η_p^2	χ^2
<i>N</i>	185 (100%)	110 (59%)	75 (41%)	—	—	—
Age (years)	11.76 ± 0.52	11.72 ± 0.47	11.88 ± 0.59	.59	.002	0.03
Gender						
Girls	86 (47%)	54 (49%)	32 (43%)	.39	.001	0.74
Boys	99 (53%)	56 (51%)	43 (57%)			
Location						
Home	49 (26%)	29 (26%)	20 (27%)	.96	.006	0.002
Flat	136 (74%)	81 (74%)	55 (73%)			
Past experiences in cycling						
Yes	170 (92%)	105 (96%)	65 (87%)	.032	.019	4.62
No	15 (8%)	5 (4%)	10 (13%)			
Cycling teachers						
Family	129 (70%)	83 (76%)	36 (48%)	.002	.048	9.68
Alone	40 (22%)	21 (19%)	19 (25%)			
Primary school	6 (1%)	19 (17%)	21 (28%)			
Secondary school	15 (2%)	5 (1%)	10 (13%)			
Initial level of cycling before the school-based intervention						
Low	20 (11%)	10 (1%)	10 (13%)	.35	.001	2.08
Medium	85 (46%)	48 (44%)	37 (49%)			
High	80 (43%)	52 (55%)	28 (37%)			
Have a bike						
Yes	125 (68%)	88 (80%)	37 (49%)	>.001	.099	19.04
No	60 (32%)	22 (20%)	38 (51%)			

Note. Group effects are between test and control groups.

17.1), $F(1.181) = 10.9$, $p = .12^{e-03}$, $\eta_p^2 = .06$, medium; cognitive (15.9 vs. 13.3), $F(1.181) = 33.48$, $p = .64^{e-07}$, $\eta_p^2 = .11$, medium; and psychological (15.9 vs. 13.3), $F(1.181) = 21.62$, $p = .31^{e-09}$, $\eta_p^2 = .16$, large dimensions.

Figure 1 shows the post hoc results. These outcomes highlighted significant differences between girls and boys in each group. In the test group, boys displayed significantly higher scores than girls for the overall score (+2.8, $p < .05$) and in the physical (+1.7, $p < .05$), cognitive (+3.2, $p < .05$), and psychological (+3.35, $p < .05$) dimensions. In the control group, boys also scored significantly higher than the girls on the overall score (+1.7, $p < .05$) and in the cognitive dimension (+2.4, $p < .05$), but these differences between boys and girls were smaller than in the test group. For the control group, girls' and boys' scores did not differ significantly in the physical (+1, $p = .39$) and psychological (+1.8, $p = .15$) dimensions.

Post hoc tests also revealed significant differences between groups for the same gender. Girls had significantly higher scores in the test group than in the control group for the overall score (+1.5, $p < .05$) and in the cognitive dimension (+3, $p < .05$) but not in the physical (+0.6, $p = .79$) and psychological (+0.8, $p = .78$) dimensions. For boys, significant differences were observed in all scores in favor of participants in the test group (overall: +2.6; cognitive: +3.8; psychological: +2.3, $p < .05$), except in the physical dimension (+1.3, $p = .09$).

Finally, post hoc tests revealed significant gender-based differences across groups. Boys from the test group displayed significantly higher scores than girls from the control group for the overall

score and all dimensions (overall: +2.6; physical: +1.3; cognitive: +3.8; psychological: +2.3, $p < .05$). However, girls from the test group did not significantly differ from boys in the control group for those scores (overall: -0.2, $p = .98$; physical: -0.4, $p = .87$; cognitive: +0.6, $p = .52$; psychological: +0.8, $p = .77$).

Discussion

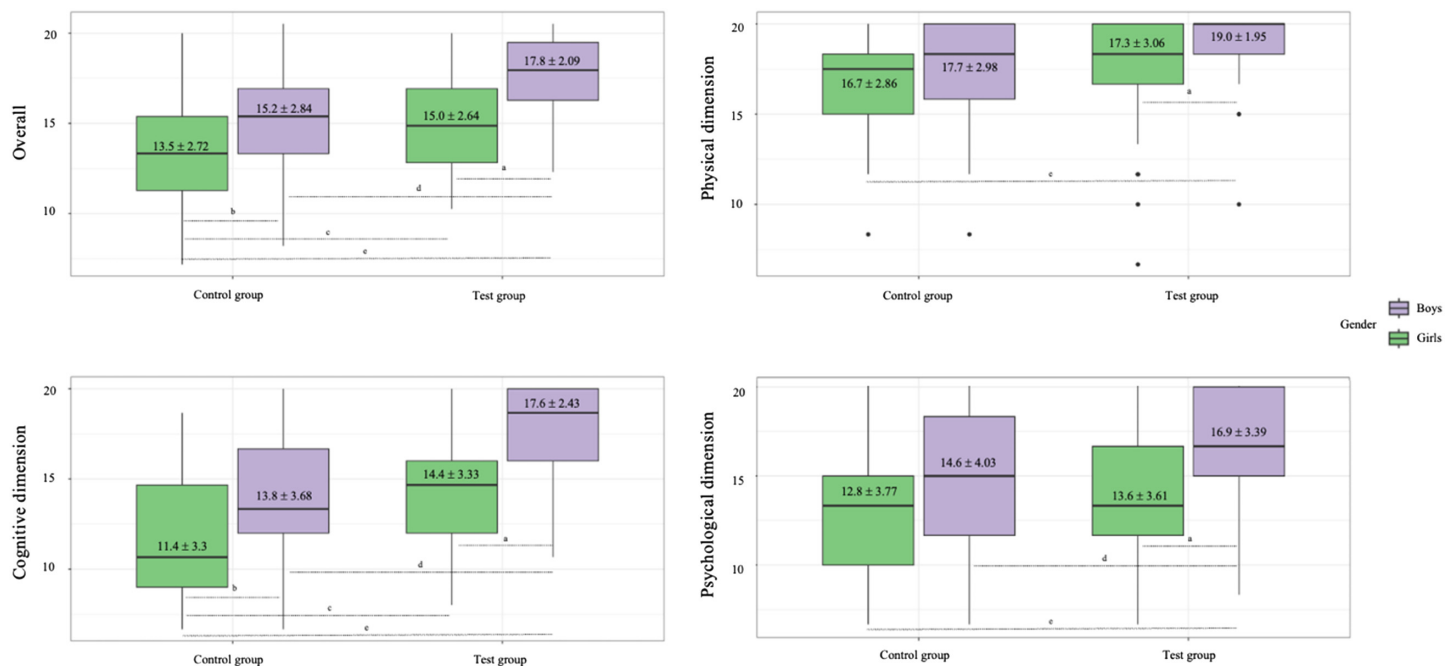
The aim of the study was to investigate the perceptions of comparative development between: (i) pupils who participated in a school-based intervention with ATS anchored in the physical literacy framework (monism, existentialism, and phenomenology) and (ii) participants who experienced a traditional PE program at the same time. Three main outcomes of the study can be summarized as follows: (i) Pupils in the test group had significantly improved their perceptions of development compared with the control group; (ii) boys always returned significantly higher scores than girls, regardless of group status; and (iii) the perceived development gap between boys and girls in the sample increased significantly.

Developing Physical Literacy Through an ATS Intervention: More Than Motor Development

This physical literacy school-based intervention through ATS revealed that the test group revealed higher scores than the control group overall as well as in the different dimensions (physical, cognitive, and psychological). Other intervention studies on

Table 4 Scores of Participants in Each Dimension With Gender, Groups, and Interaction Effect From a Two-Way Analysis of Variance

	Overall score	Physical dimension	Cognitive dimension	Psychological dimension
Whole sample	15.7 ± 3.0	17.8 ± 2.8	14.7 ± 4.0	14.7 ± 3.8
Groups				
Test	14.9 ± 2.2	16.4 ± 1.9	16.0 ± 3.3	15.3 ± 3.9
Control	13.4 ± 2.6	15.3 ± 2.4	12.8 ± 3.7	13.8 ± 4.0
Gender				
Girls	14.5 ± 2.8	17.1 ± 3.0	13.3 ± 3.7	13.3 ± 3.6
Boys	16.7 ± 2.8	18.4 ± 2.5	15.9 ± 3.8	15.9 ± 3.6
Effects				
Groups	$p < .01$, $\eta_p^2 = .14$	$p = .26^{e-02}$, $\eta_p^2 = .03$	$p < .01$, $\eta_p^2 = .04$	$p < .01$, $\eta_p^2 = .22$
Gender	$p < .01$, $\eta_p^2 = .16$	$p < .01$, $\eta_p^2 = .06$	$p < .01$, $\eta_p^2 = .11$	$p < .01$, $\eta_p^2 = .16$

**Figure 1** — Scores of participants according to gender and group in each dimension. ^aSignificant differences between girls and boys in the test group; ^bSignificant differences between girls and boys in the control group; ^cSignificant differences for girls between test and control group; ^dSignificant differences between boys in the test and control groups; ^eSignificant differences between boys from the test group and girls from the control group.

ATS have also tended to reveal an increase in daily PA levels (Villa-González et al., 2017; Carlson et al., 2020), but these findings were not articulated in the nomenclature of physical literacy philosophies. This study is the first to highlight better outcomes than those that have exclusively targeted the physical dimension only. This finding is in line with the promising results of physical literacy interventions reported to date (Carl et al., 2022). Although this study does not record levels of actual PA engagement, it does show that teaching activities, following physical literacy dimensions (monism), contextualized in an environmental and safe context (existentialism), and with an adaptation to the needs of each pupil (phenomenology), provide a promising educational context. In this quasi-experimental study, (i) the absence of a baseline condition (no pretest design) does not allow the range of improvement to be measured, and (ii) the impossibility to control every extraneous variable nuanced the findings. However, the fact

that overall physical literacy and its dimensions are higher in the test group compared with the control group seems to be an encouraging result that is consistent with our hypothesis.

In the French national context, Vieille-Marchiset et al. (2019) provided interesting data on the social influences on bicycle use after an educational intervention. They attempted to adopt a more monistic approach as psychological, cognitive, and physical dimensions of behavior were investigated. The study also took place in a situated context, emphasizing the actor's perspective, respecting the existentialist and phenomenological philosophical pillars for a physical literacy-based intervention. They showed that traditional ATS interventions do not help participants completely develop technical control of the bike in and out of the neighborhood and led to a lack of socialization due to family constraints, particularly those linked to a gender split. One perspective for future interventions of this type could involve

examining the interactions between family members. Indeed, Lane et al. (2022) also showed that interventions designed according to the concept of physical literacy supported parents' confidence with formal educational organizations. Developing an institutional "How to ride a bike" program based on concepts of physical literacy could promote educational continuity between schools and families.

Another limitation of this study is the lack of attention to the social dimension, which was not scrutinized because it did not emerge as a significant variable from the statistical analysis of the data. Although questions may be raised about the importance of the social dimension of the questionnaire, when the educational objective is the development of performance behaviors of each individual cyclist (getting around safely), interaction with other road users requires the development of behaviors in the social dimension for health and safety purposes. Indeed, the social dimension has been increasingly included in the metric and epistemological proposals for physical literacy (Gandrieau et al., 2023; Mota et al., 2022; Barnett et al., 2021).

The Perception of Development: Essential for Practices With Safety Issues

When pupils have a better perception of their personal development, they will have a positive perception of the task and will, therefore, be more likely to engage more effectively (Fréchette-Simard et al., 2019), more sustainably (Lemoyne et al., 2015), and more safely (Mercê et al., 2021) in specific performance behaviors needed in cycling. Mercê et al. (2021) also showed that clear perception of surroundings affects the development of relevant skills in cyclists, possibly enhancing opportunities for participation in lifelong PA, including other cycling activities and all ATS practices. The results of this physical literacy school-based intervention showed that perceptions of personal development were significantly higher for the test group for all dimensions, leading to a physically active lifestyle. However, it would have been relevant to collect information on questions related to participants' previous experiences to avoid drawing hasty conclusions, such as: are differences observed in participants due to societal factors or to veritable differences in skills perception? There is also a need for more follow-up information on the persistence of long-term PA engagement after the intervention.

The question of perception of participants' physical literacy levels has already been debated in the literature but not in the context of ATS for engagement in sustainable and safe PA. For example, the conception of Li et al. (2021) on the Chinese context includes a sensory-perceptual dimension without defining it. Analysis of this perceptual dimension requires further research, in particular to investigate the relationship between perceived and actual development for external validity of an instrument to measure perception.

Gender Differentiation: A Challenge Still To Be Grasped

Boys' overall scores were significantly higher than those recorded for the girls in the sample (14.5 vs. 16.5, $p < .05$) for perceptions of physical (16.5 vs. 14.5, $p < .05$), cognitive (15.9 vs. 13.5, $p < .05$), and psychological behaviors (15.9 vs. 13.3, $p < .05$). These findings confirmed the results of Vieille-Marchiset et al. (2019), who reported that boys are more able to cycle than girls following the interventions carried out. These results converge with data reported

in the studies by Vallerand and Thill (1993), who suggested that boys generally express a higher perception of development than girls, even if this is not justified by actual development levels. There may be many reasons for these sex-based differences that need to be further explored. Despite this observation, many previous studies have looked at psychosocial variables in the use of ATS, showing that boys from socially-advantaged neighborhoods tend to maximize their opportunities for using a bicycle as an ATS (Chen et al., 2021). The results of the current study are not conclusive on this point.

In the test group, boys displayed significantly higher scores than girls in all physical literacy dimensions, whereas sex-based differences were observed only in the cognitive dimension in the control group. In other words, differences appeared in the physical and psychological dimensions, and existing differences in the cognitive dimension increased. These results contradict the ideas of Kriellaars et al. (2019) on preexisting physical literacy school-based interventions. They showed that teaching circus arts according to physical literacy needs led to greater gender equity, particularly in the physical dimension. Effects on the other dimensions have yet to be explored. Perhaps the intervention was not tailored enough to the educational needs of women or, due to subconscious bias in the researchers, may have been slanted toward the lived experiences of male participants in the study. In other words, the study seems to have been successful in providing monist and existentialist philosophies but may be improved in taking into account the phenomenological pillar of physical literacy.

This potential limitation is interesting because it points to the challenge of considering gender differentiation in research studies, which may especially need to be clarified in greater detail in the development of future physical literacy school-based interventions. Since this intervention was carried out, the Physical Literacy Interventions Reporting Template guide has been designed to guide the coconstruction of physical literacy interventions (Carl et al., 2023). Based on this new framework, it would be interesting to explore the effects of gender in depth to propose pedagogical adaptations to ensure that girls and boys adopt an equitable physically active lifestyle.

Perspectives

This study's originality stems from being the first to examine participants' perceptions in an intervention of development of each of the physical literacy dimensions, which are considered essential for a sustainable and safe PA lifestyle. One of the main strengths of this study is the coconstruction of a physical literacy school-based intervention by academic researchers and practitioners. It follows recommendations of Van Sluijs et al. (2021), which highlight that a supportive school environment is one of the three necessities for reducing physical inactivity in teenagers. In the future, it may be important to encourage more of these collaborations between applied scientists and practitioners. Esiet et al. (2023) revealed that few PE teachers actually attempt to teach physical literacy, and Popp et al. (2022) demonstrated the impact on the whole community, in the case of public health interventions, of using PA in the health care professions. These collaborations have already been proposed in a French White Paper on education (Fabre et al., 2023).

There are three things to be carefully avoided to prevent methodological and epistemological confusion. First, ATS cannot be reduced to cycling as it also includes walking, rollerblading, running, scooting, and skateboarding. Next, with a quasi-experimental design, there is no "cause and effect" relationship, as there

are too many uncontrolled, extraneous variables. Finally, physical literacy is a generic concept that can be applied to other activities, and there is still a need for numerous educational analyses and proposals. Incorporating it into PE teacher training courses could lead to a change in conceptualization of activity, inviting reflection on the role of a PE teacher as an architect of pupils' physical lifestyles. More than just a teacher of children and a technician of PA, the PE teacher could be an impactful force for program design who drives, promotes, guides, and innovates on a local level.

Implications for Policy and Practice

In France, almost 56% of public and private sector employees declare being unable to work remotely and travel to work each day (ONAPS, 2023). Considering that only 6% of journeys to school or workplace are made by bicycle (ONAPS, 2023), active transport (by different modes) is a major challenge that needs to be learned from an early age. ATS education programs, in which the safety aspect is essential, may be effective when they are coconstructed by the educational and scientific communities and adapted to the philosophical foundations of physical literacy with the specificities of the contexts. Physical literacy programs could complement changes in educational (programs) and environmental policies (safe cycling development of built environment and infrastructure networks), creating multilevel support for enhanced effectiveness. Practitioners and scientists should collaborate more closely to increase the number of interventions for analyzing effectiveness of these programs. The school-based intervention reported here combined the development of cycling and physical literacy to encourage possibilities offered to PE teachers for simultaneously exploring ATS and the issue of promoting physically active and safe lifestyles.

Acknowledgment

We would like to thank the team of PE teachers from the Descartes secondary school and the Sport Department of Le Blanc-Mesnil, in France, for enabling us to carry out this study.

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