

# Innovation in physical education: Proprioception, periferical vision, self-awareness, and sustainability

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## ABSTRACT

In an era that increasingly emphasizes the importance of sustainable lifestyles, this study aims to explore the potential role of physical education in improving, through the training of proprioception and peripheral vision, self-awareness and attention, and to verify their possible correlation with virtuous behaviours. Utilizing applications of the Synchrony methodology within the context of embodied cognition, it is hypothesized that a greater sense of bodily awareness, achieved through targeted physical training, may promote behaviours oriented towards sustainability. This hypothesis is based on the idea that enhanced self-awareness and/or attention could lead to a better understanding of one's living space, personal choices, and their consequences, thereby increasing responsibility towards the shared living environment. A pilot observational study and a subsequent experimental study involving 84 high school students were conducted to outline these potential aspects of indirect connection between specific physical training and more responsible behaviours, with the aim of helping, in the future, young people to develop such qualities also through specially designed physical education methodologies.

**Keywords:** Physical education, Self-awareness, Pre-adolescents, Sustainable choices, Innovative teaching.

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## INTRODUCTION

Physical education, traditionally focused on physical well-being, has gained new relevance in recent years due to an increasingly digitalized global context, early decreases in physical activity, and radical changes in diet, especially in industrialized countries. Such socio-cultural changes have induced a growing interest in physical education as a possible tool for overall well-being, not just physical. Recent studies indicate physical activity as necessary for the physical well-being of young people and also crucial for their cognitive development, especially where environmental changes have been fastest for younger populations (Spengler, 2018; Jassen, 2010; Tomporowski, 2008).

From this perspective, Bailey et al., as early as 2009, emphasized how regular physical activity contributed both to maintaining good health and to healthy mental and emotional growth in children (Bailey, 2009; Draper et al., 2010). The increasing awareness of the multidimensional benefits of physical education has led several countries to reassess the importance of this discipline in their educational systems. In Europe, for example, the HELENA project (Healthy Lifestyle in Europe by Nutrition in Adolescence) highlighted the importance of regular physical activity for young people, influencing educational policies in various countries and exploring the concept of healthy sustainable eating (Moreno et al., 2010). In Canada, the ParticipACTION strategy aimed to increase physical activity in the child population, emphasizing the need to expand the hours dedicated to physical education in schools as a tool for healthy cognitive-motor growth (Tremblay et al., 2011). In the United States, the "*Physical Activity Guidelines for Americans*" by the Department of Health and Human Services encouraged an increase in physical activity by proposing, in addition to increasing the hours of physical education at school, also extracurricular motor programs aimed at stimulating social skills (U.S. Department of Health and Human Services, 2018). Physical-motor education has thus broadened its scope of reference, beginning to position itself as a possible tool for broader improvement (Hillman, Erickson, & Kramer, 2008). Also in Italy, through the PNRR (National Recovery and Resilience Plan), an additional step forward is being sought by introducing strategic investments in education to promote innovative and inclusive physical education, to support sustainable development and the well-being of young people.

In this international context, the theory of embodied cognition emerges as an important tool for understanding the interconnection between mind and body in learning across disciplines. This approach emphasizes how physical experience directly and fundamentally influences the cognitive process, highlighting an indissoluble link between physical action and thought (Wilson, 2002; Barsalou, 2008; Niedenthal, 2007; Shapiro, 2011; Gallese & Sinigaglia, 2011; Lakoff & Johnson, 1999). Structured physical activity can thus be used as a possible vehicle for improvement for both generic and specific cognitive abilities, such as self-awareness, with results especially in young people (Pérez-Romero et al., 2023; Di Giacomo et al., 2017). This observation becomes particularly relevant in a historical period characterized by intense use of digital technologies by children and adolescents (Benzing & Schmidt, 2019; First, 2017), which often leads to a reduction in physical activity and social interactions. Faced with such changes, concerns arise regarding their cognitive development and their ability to critically judge (Nurhafid & Nursasi, 2019). Hence, the link between physical activity and cognitive well-being becomes even more critical. Therefore, it might be important to study physical education programs that are not limited to generic exercise but include activities specifically designed to stimulate positive behaviours in young people, for the possible strengthening of cognitive and social skills. Such a multidisciplinary approach to physical education could therefore meet the complex development needs of young people, offering them an additional opportunity to assimilate skills, fundamental for their overall well-being (Hillman, Erickson, & Kramer, 2008; Tomporowski, Davis, Miller, & Naglieri, 2008; Ratey & Hagerman, 2008; Best, 2010).

In light of the above, the authors have chosen to use the Sincrony movement education methodology, considered an innovative approach in this field. In line with the principles of embodied cognition, this methodology indeed aims to develop mechanical movement abilities in conjunction with cognitive ones, intervening with targeted and specifically validated tools in the key phases of development. Sincrony, through specific exercises, consolidates or increases body perception capacity, and visual skills, with possible results implied in a broader plan of health and development of social skills. (Routen et al., 2018; Nyberg & Larsson, 2017; O'Hagan et al., 2022) Franzini et al. (2009) also provided further perspectives on the interconnection between the physical and social environment in children in their study, highlighting how these two aspects are closely linked. This research has emphasized the existence of a profound relationship between different dimensions of child experience, reporting a further point of intersection between elements that might seem distant at first glance (Franzini et al., 2009).

In the context of physical education aimed at different juvenile ages, recent studies have highlighted the importance of integrating exercises aimed at enhancing self-awareness as a means to promote comprehensive development and a greater understanding of the social consequences of behaviours. These exercises have been recognized for their potential in increasing not only the physical competencies of students but also their cognitive and relational abilities. For example, a 10-week physical education intervention showed a positive impact on primary school students' self-concept regarding their endurance and strength, improving both perceived self-efficacy levels and confidence in their physical abilities, suggesting a beneficial effect of functional self-concepts in education for motor tasks (Schmidt, 2013). Furthermore, physical education has been identified as an effective means to improve self-esteem and promote social development, with a positive attitude towards other students being observed in secondary schools, highlighting the significant role of physical activity in the social and cognitive development of students (Kim & Shin, 2021).

In this multifactorial context, with growing attention to sustainable lifestyles and the need to develop personal and social awareness in young people, the present study aims to explore the role of physical education in promoting comprehensive development that embraces both the physical and cognitive-social aspects. As already expressed, the focus will be on the Sincrony methodology, situating it in the context of embodied cognition, to investigate how an enhanced bodily awareness, obtained through proprioceptive physical training and peripheral vision, in a group of preadolescents, and how it may potentially encourage sustainable behaviours. The authors hypothesize that an increase in proprioception reflects on self-awareness and may facilitate a deeper understanding of personal decisions and their repercussions, while work on peripheral vision may predispose to better space management, thus potentially enhancing responsibility towards others and the shared environment (Survey on Students et al., 2015; Werdermann, 2020; Ojedokun & Balogun, 2010; Koike, 1994; Strömbäck et al., 2023). The Sincrony method was chosen because, by its nature, it uses and combines the stimulation of proprioception and vision as necessary tools in training, integrating them into motor actions and their execution.

Through an observational pilot study, parameters were assessed to conduct an experiment in secondary schools, attempting to outline how, and if, physical training, studied ad hoc with the Sincrony methodology, can indirectly influence more responsible behaviours, providing insights for future physical educational methodologies specifically designed. The main goal was to examine how this innovative approach to physical education could influence the development of self-awareness and, potentially, promote sustainable behaviours among preadolescents through neuropsychological tests, field tests, and evaluative questionnaires. The choice of the Sincrony methodology is rooted in a multidisciplinary conception of physical education that sees movement not only as a tool for improving performance capabilities but also as a vehicle

for strengthening cognitive and relational capacities, including self-awareness as a possible bridge to sustainable attitudes (Castelli, 2007; Hagger, 2002; Singh, 2012; Stodden, 2008). In this context, it could therefore be important to evaluate the effects of protocols from innovative methodologies, which highlight how mind and body are interconnected, or at least not divisible, and by exploiting physical works on specific variables have a possible impact on behaviour (Castelli, 2007; Hagger, 2002; Singh, 2012; Stodden, 2008).

## MATERIALS AND METHODS

### ***First experiment: evaluative pilot***

A pilot study was conducted to identify any issues that might arise in a multifactorial study, allowing for the testing and refining of data collection methodologies, questionnaires, and instruments for the experiment. It involved a carefully selected group of 14 eleven-year-old girls, chosen from the students of a secondary school based on specific extracurricular needs. Students without interests in the ecological field were selected to evaluate the baseline effectiveness of the educational intervention (Stanley, 2011).

The decision to focus exclusively on a female sample was driven by evidence emerging from previous research, which demonstrated better responsiveness to personalized physical education programs in females. Specifically, research like that conducted by Gordienko (2015) or Tüdös et al. (2020) has suggested that girls can benefit more markedly and verifiably from motor educational programs that take into account specific needs or learning modalities (Gordienko, 2015; Tüdös et al., 2020). All the girls had a medical certificate for physical-sports practice. Before conducting the tests with recording, a specific familiarization session was held. No test was trained during the 5 weeks of training, and no specific training on the qualities tested was directly carried out. The sample was chosen to be only female to reduce possible interfering variables.

Table 1. Types of exercises performed in the pilot study divided between the experimental group and the control group.

Week	Experimental group (Sincrony methodology)	Control group (Unspecific physical activity)
1	Warm-up with proprioceptive focus, peripheral games, and static centring exercises.	General warm-up, free play, relays, cooldown
2	Body warm-up with proprioception, peripheral coordination Static centring.	General warm-up, ball games, team activities
3	Warm-up with peripheral focus, movement-breath synchronization, dynamic centring.	Dynamic warm-up, obstacles, speed, running games
4	Movement awareness during warm-up, agility games in peripheral, centring.	Movement games, group activities, stretching
5	Proprioception, respiratory work, games with centring and peripheral.	Warm-up exercises, obstacle courses, cooldown

The pilot sample was divided into two groups: 7 participants in the control group and 7 in the experimental group. Participants were assigned to groups through simple randomization. The experimental group participated in an integrative physical education program based on the Sincrony methodology. The control

group, on the other hand, carried out unspecific physical integrative activity. Both groups participated in two 30-minute sessions per week for a total of 5 weeks.

In the experimental group, the exercises included improving peripheral vision, proprioception, and diaphragmatic breathing techniques. In the control group, general physical exercises were conducted without a specific focus.

Evaluations for both groups were conducted across three different dimensions:

- Attention: Both groups were assessed using the Trail Making Test A, a standardized tool for evaluating executive functions and attention (Tombaugh, 2004). The Trail Making Test Part A is a standardized neuropsychological procedure used to assess cognitive processing speed and attention. During this test, the girls had to connect a series of numbers randomly distributed on a sheet of paper as quickly as possible without lifting the pen. The primary objective was to complete the test as quickly as possible, with the time taken being the main performance indicator (Bowie, 2006; Lezak, 2012).
- Self-awareness: The Stork Stand Test for balance was used to assess bodily self-awareness expressed in the ability to maintain the correct level of muscle tension in a balance task. Previous studies have indeed correlated the ability to maintain balance with greater body awareness (Prosperi et al., 2019). The Stork Stand Test was performed with the following procedure:

The participant removed their shoes and stood on a flat surface. Then, they had to lift one foot by bending the knee and resting the sole of the foot on the inner side of the opposite knee, mimicking the stance of a stork. Arms were placed at the sides, bent with hands resting on the hips. The goal was to remain in this position for as long as possible without losing balance, tilting the torso, or hopping. The evaluation was represented by the sum of the durations, measured with two stopwatches by a double experimenter (Johnson, 1979; Schell 1994).

- Behavioural Observations: Qualitative evaluations, Sustainable behaviours, were made on the use of changing rooms, a shared common space, to assess possible changes towards sustainability in behaviour. The teacher conducting these evaluations was unaware of the children's group affiliations to maintain objectivity; the dedicated teacher had followed a blind procedure and had never attended the lessons. The children were not made aware of these evaluations. The responsible teacher had to assign a score in the established macro-areas.

Table 2. Observational macro-areas.

Evaluation criterion	Description	Assigned score (1 or 0)
Responsible Water Use	Turning off the taps after use.	1 = Always closed 0 = Left open
Waste Management	Disposing of waste, tissues, etc., in the appropriate recycling bins.	1 = Correct use of bins 0 = Incorrect use or litter on the ground
Order and Cleanliness of Space	Keeping order and cleanliness in the common space, not leaving clothes around.	1 = Orderly and clean 0 = Disorderly or dirty
Energy Saving	Turning off the lights when not needed.	1 = Lights off when not needed 0 = Lights left on
Shared and Respectful Use of Resources	Sharing space and resources (benches, lockers, hangers) fairly.	1 = Fair sharing 0 = Excessive occupation or exclusive use

**Experiment**

In light of the encouraging results obtained from the pilot experiment, a second, more extensive experiment was undertaken with the aim of exploring the impact of the Sincrony methodology on a larger sample,

diversified in terms of age. Given the feasibility of fieldwork, the experimentation weeks were increased to 12. (Kim, 2020) Additionally, 40 students for the experimental (work) group and 30 for the control sample aged between 10 and 13 years (average age 12) were selected from various secondary schools. The choice to include students of this age range is based on evidence suggesting a significant variation in responses to physical education during these ages are crucial for development (Eime et al., 2013; Smith et al., 2019). Moreover, based on the results of the pilot experiment, the same initial extracurricular screening was performed, with the addition of excluding girls who already participated in similar motor programs in their sports. Furthermore, the training protocol for the experiment was structured to last 10 weeks, with bi-weekly sessions of 45 minutes each, to better adapt to the evolutionary needs of the participants and to allow a deeper assimilation of the principles of the Sincrony methodology. This decision was made based on both the observations collected in the pilot experiment and the literature that emphasizes the importance of the duration and frequency of the intervention to maximize the potential impact on self-awareness and sustainable behaviours (Durlak et al., 2011; Beets et al., 2016).

In this case, too, the sample was divided into two groups through a process of stratified randomization, taking into account age and gender, to ensure a fair distribution of participant characteristics between the experimental group (40 students) and the control group (30 students). This approach was designed to reduce potential confounding variables and to ensure the reliability of the results (Kraemer et al., 2002).

For the experimental group, the exercises were designed to include a greater variety of activities to increase proprioception and spatial awareness, as per the pilot protocol, integrating them with a greater part of explanation and correction (Best, 2010; Pesce, 2012).

As in the pilot, the evaluation of performance and behaviours was conducted using validated tools and observational measures, such as the Trail Making Test for attention assessment and the Stork Stand Test for self-awareness, in line with previous evaluation protocols (Tompsonski, 2003; Haga, 2008).

**RESULTS**

The data were analysed using SPSS software. No subjects were excluded from the sample. No outlier values were found.

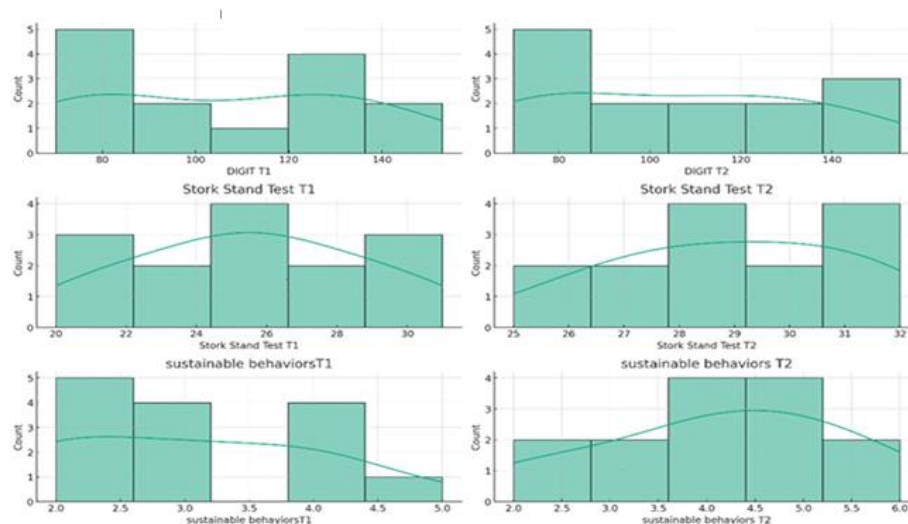


Figure 1. Distribution of pilot data.

### **Pilot analysis**

The sample size was small, therefore the normality tests conducted are considered less reliable compared to a larger sample size. Nonetheless, they were necessary to verify the distribution of the sample.

Analysis of distributions through the visual reproduction of histograms (Figure 1).

The observed distributions highlight differences in distribution for the various study variables. The presence of peaks, asymmetries, or irregular distributions suggests that some of the variables do not follow a normal distribution, while others do. Therefore, specific tests will be conducted based on the distribution of the variable under examination.

#### *Analysis of distributions through the Shapiro-Wilk Test*

TMT T1: Shapiro-Wilk Statistic = 0.914,  $p$ -value = .182.

TMT T2: Shapiro-Wilk Statistic = 0.928,  $p$ -value = .284.

Stork Stand Test T1: Shapiro-Wilk Statistic = 0.979,  $p$ -value = .969.

Stork Stand Test T2: Shapiro-Wilk Statistic = 0.958,  $p$ -value = .692.

Sustainable Behaviours T1: Shapiro-Wilk Statistic = 0.862,  $p$ -value = .033.

Sustainable Behaviours T2: Shapiro-Wilk Statistic = 0.923,  $p$ -value = .243.

#### *ANOVA for Variables with a Normal Distribution*

ANOVA for TMT (T1 vs T2): F-statistic = 0.0106,  $p$ -value = .919. The high  $p$ -value (.919) suggests there are no significant differences between TMT T1 and TMT T2.

ANOVA for Stork Stand Test (T1 vs T2): F-statistic = 8.533,  $p$ -value = .0071. The  $p$ -value of .0071 indicates a significant difference between Stork Stand Test T1 and T2.

#### *Kruskal-Wallis Test for Variables with Non-Normal Distribution*

Kruskal-Wallis Test for Sustainable Behaviours: Kruskal-Wallis Statistic = 5.397,  $p$ -value = .0202. The  $p$ -value of .0202 indicates a significant difference between Sustainable Behaviours T1 and T2.

The results showed significance in variance for the parametric variable Stork Stand Test and the non-parametric variable Sustainable Behaviours; therefore, further analyses of these variables will be conducted.

- Stork Stand Test (Parametric Analysis): We will compare the means between the control group and the experimental group for both T1 and T2 using a t-test.

Control Group: t-test Statistic = -2.83,  $p$ -value = .03.

Experimental Group: t-test Statistic = -41.0,  $p$ -value = .002.

- Sustainable Behaviours (Non-Parametric Analysis): We will compare the means for the control and experimental groups for both T1 and T2 using the Mann-Whitney Test.

Control Group: Mann-Whitney U Statistic = 30.0,  $p$ -value = .504.

Experimental Group: Mann-Whitney U Statistic = 5.5,  $p$ -value = .0153.

#### *Pilot discussion*

The analysis of the pilot data highlighted significant differences in sustainable behaviours and the balance test (Stork Stand Test) between pre-tests and post-tests, indicating potential positive effects of the intervention. These results suggest that the program could indeed have effects and that the chosen protocols should therefore be further investigated.

**Experiment**

*Descriptive Statistics*

- Experimental Group (Group 1)

TMT T1: Mean = 120.98, Standard Deviation (SD) = 20.68.

TMT T2: Mean = 117.95, SD = 20.39.

Stork Stand Test T1: Mean = 27.88, SD = 1.90.

Stork Stand Test T2: Mean = 27.45, SD = 2.12.

Sustainable behaviours T1: Mean = 3.83, SD = 1.08.

Sustainable behaviours T2: Mean = 3.75, SD = 1.15.

Age: Mean = 11.93, SD = 0.86.

- Control Group (Group 0)

TMT T1: Mean = 117.37, SD = 16.43.

TMT T2: Mean = 117.47, SD = 16.30.

Stork Stand Test T1: Mean = 28.23, SD = 2.21.

Stork Stand Test T2: Mean = 28.27, SD = 2.26.

Sustainable behaviours T1: Mean = 3.37, SD = 1.00.

Sustainable behaviours T2: Mean = 3.33, SD = 0.92.

Age: Mean = 11.80, SD = 0.81.

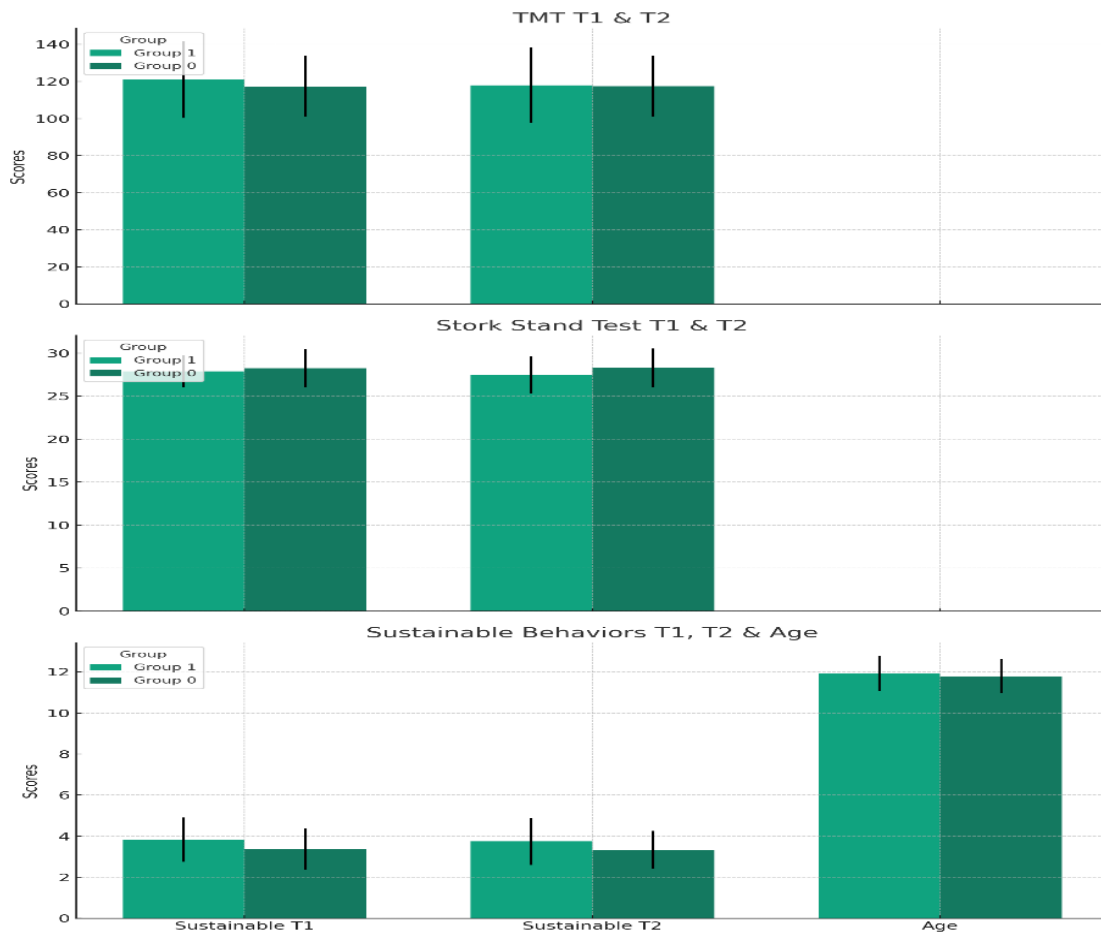


Figure 2. Descriptive distribution of the experiment.



### *Normality Testing Results*

The results of the Shapiro-Wilk test indicate that none of the analysed variables follow a normal distribution:

TMT T1:  $p$ -value = .0043.

TMT T2:  $p$ -value = .0111.

Stork Stand Test T1:  $p$ -value = .000176.

Stork Stand Test T2:  $p$ -value = 9.56 (This  $p$ -value seems incorrect as it exceeds the range [0,1]. It might be a typographical error).

Sustainable Behaviours T1:  $p$ -value = 2.04 (This  $p$ -value also seems incorrect for the same reason).

Sustainable Behaviours T2:  $p$ -value = 2.08 (This  $p$ -value again seems incorrect for the same reason).

These results suggest that the data do not satisfy the assumption of normality.

### *Wilcoxon Test*

The Wilcoxon Test was applied to compare medians between pre- and post-intervention measurements (T1 and T2) for each variable, in both control and experimental groups.

- Experimental Group (Work Group)

In the Experimental Group, the Wilcoxon Test revealed significant differences for some variables:

TMT T1 vs TMT T2:  $p$ -value = .048.

Stork Stand Test T1 vs T2:  $p$ -value = .033.

Sustainable Behaviours T1 vs T2:  $p$ -value = .017.

The significant differences found in the Experimental Group for these variables suggest that the intervention had a positive impact, leading to significant changes in sustainable behaviour and balance abilities.

- Control Group

For the Control Group, the Wilcoxon Test did not show statistically significant differences for any of the considered variables, as indicated by the following  $p$ -values:

TMT T1 vs TMT T2:  $p$ -value = .310.

Stork Stand Test T1 vs T2:  $p$ -value = .215.

Sustainable Behaviours T1 vs T2:  $p$ -value = .462.

These results suggest that there were no significant changes in the control group between the two measurement times.

### **Correlation analysis**

Correlation analyses between the variables "*Delta T1-T2 for Stork Stand Test*" and "*Delta T1-T2 Sustainable Behaviours*" were conducted to examine if there was a significant relationship between these variables. Both the Kendall's Tau-b coefficient and the Spearman's Rho coefficient were utilized, and the results indicated a positive correlation between the two variables.

Specifically, the Kendall's Tau-b coefficient was found to be 0.275, with a  $p$ -value of .005, indicating that the correlation is statistically significant at the 1% level (two-tailed). This suggests that, generally, an increase in performance in the "*Stork Stand Test T2*" is associated with an increase in "*Sustainable Behaviours T2*".

Concurrently, the analysis using Spearman's Rho coefficient highlighted a slightly stronger correlation, with a coefficient of .299 and a  $p$ -value of .011, confirming statistical significance at the 5% level (two-tailed). This

reinforces the evidence of a positive correlation between performance in the balance test and sustainable behaviours.

Both results, derived from 71 observations, support the existence of a significant relationship. However, it is important to emphasize that although there is a statistically significant correlation, this does not necessarily imply a causal relationship between the two variables. Further research might be necessary to explore the nature of this association.

### ***Experiment results discussion***

The statistical analysis conducted with the Wilcoxon Test on the experiment data revealed different outcomes for the control group and the experimental group. In the Control Group, the results do not show significant differences between T1 and T2 times for any of the variables considered. This implies that, without the intervention, there have been no appreciable changes in the subjects' performances in the variables of interest, such as balance and sustainable behaviours.

Conversely, the Experimental Group shows significant improvements. The differences in p-values in the Wilcoxon Test indicate that there has been a significant variation in performances measured by the TMT and the Stork Stand Test, as well as a change in sustainable behaviours. These findings suggest that the intervention could be the direct cause of these improvements.

## **DISCUSSION**

The data from the Trail Making Test (TMT) Part A showed no significant differences pre- and post-intervention neither in the pilot experimental group nor in the control, suggesting that the initial intervention did not have a direct measurable impact on attention or visual and motor processing speed. In the main experiment, only the experimental group showed a slight improvement in TMT Part A completion times from pre to post-test, indicating a potential positive influence of the more prolonged and structured intervention on attention and processing capabilities, though not significant. Transitioning from the pilot study data analysis to the main experiment highlights how the intensification and longer duration of the intervention might have contributed to a slight improvement in performance in the Trail Making Test (TMT) Part A.

Data related to the Stork Stand Test showed a significant improvement from pre to post-test in the experimental group but not in the control in the pilot experiment, indicating an increase in balance and body self-awareness. The main experiment confirmed the pilot study results, with further improvements recorded in the experimental group, suggesting that the prolonged and more structured intervention had a possible greater impact.

The data on sustainable behaviours, based on behavioural observations recorded by personnel in a blind manner, showed a significant change in the representative values of sustainable behaviour, especially those related to spatial variables, for the experimental group in the pilot study. In the main experiment, this data was strengthened, showing that participants in the experimental group maintained and improved their sustainable behaviours, even on other considered variables.

The progression from the pilot study data to the main experiment shows consistency in the improvement of the assessed metrics: both for self-awareness measured through the Stork Stand Test and for observed sustainable behaviours.

## CONCLUSIONS

This study aimed to explore the impact of innovative physical education that combined proprioceptive work with movement, using the Sincrony methodology. Quantifiable physical parameters were sought to measure self-awareness, attention, and sustainable behaviours in a sample of youth.

**Self-awareness and Balance:** The results demonstrated significant improvements in self-awareness and balance abilities, measured through the Stork Stand Test, for participants subjected to the intervention. This suggests that the Sincrony methodology could effectively increase body awareness in youth, a fundamental aspect for physical and mental well-being.

**Sustainable Behaviours:** The intervention led to significant changes in participants' sustainable behaviours, as observed in behavioural evaluations. This indicates that physical education, when properly structured, can play a crucial role in promoting environmental responsibility and eco-friendly behaviours among the youth.

**Attention:** Although the results of the Trail Making Test Part A did not show significant immediate improvements, the main experiment displayed a trend towards improvement in attention and processing speed performances, suggesting that more prolonged and intensive interventions might be necessary to observe significant effects in this area.

The potential efficacy of innovative physical education underscores the importance of studying teaching methodologies and new approaches to stimulate sustainable behaviours. Physical education, by promoting movement, allows for promoting healthy physical, social, and cognitive growth in youth. It would be interesting if, through new methodologies, it could also contribute to the formation of individuals who are more responsible and attentive to others and the environment around them. To further consolidate these results and explore the potential of innovative physical education, future research on larger and more diverse samples is advisable, evaluating the efficacy of longer-duration interventions. Additionally, investigating the integration of such educational programs with other school subjects would promote cross-disciplinary and holistic learning that encourages not just academic excellence but also the development of essential personal and social skills.

## AUTHOR CONTRIBUTIONS

The paper is the result of coordinated and collaborative work by the Authors. In particular: Antinea Ambretti wrote "*Introduction*" and "*Materials and methods*"; Arianna Fogliata wrote "*Data analysis*"; Davide Di Palma wrote "*Discussion*" and "*Conclusion*".

## SUPPORTING AGENCIES

No funding agencies were reported by the authors.

## DISCLOSURE STATEMENT

The authors declare that there are no conflicts of interest that could have influenced the course or outcomes of this study. All funding and resources used for the research were employed solely for scientific purposes and are not influenced by external obligations that could compromise the integrity of the research.

## ETHICAL STATEMENT

This study was conducted with utmost respect for international ethical principles concerning non-clinical research with human subjects, paying particular attention to the protection of minors involved. The authors adopted a rigorous approach to ensure that all procedures respected the rights and well-being of the participants, in line with the Declaration of Helsinki guidelines. Before data collection began, we obtained written informed consent from the legal guardians of every minor involved in the study.

We ensured that participation was entirely voluntary and that guardians and minors could withdraw from the study at any time without any penalty. The information collected during the study is treated with the utmost confidentiality and has been anonymized to protect the participants' identities.

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