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Study on the integration of peripheral vision in physical education: the body as a tool for learning and balance in adolescents of the technological era

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Abstract: In the digital age, young people are immersed in a technological environment that limits physical movement and promotes fragmented perception, negatively affecting attention and motor skills. This study explores an innovative approach, integrating peripheral vision training into physical education to enhance both motor and cognitive aspects. The aim is to counteract the "disembodiment" typical of the post-human era, restoring the body's central role. Fifty-six adolescents (mean age 12.6 years) were divided into two groups: experimental and control. Both participated in a three-month physical education programme, but only the experimental group received interventions based on the Sicrony method, focusing on peripheral vision stimulation. Cognitive and motor performance were assessed through standardised tests (TMT-B, SEBT, VST) at the start (T0) and end (T1) of the programme. The experimental group showed significant improvements in the TMT-B ($p=0.003$) and VST ($p<0.05$) tests, suggesting that body and vision training positively influenced attention and visual recognition. The findings support an integrated educational approach that values the body in the learning process, balancing the impact of technology and fostering balanced development. This perspective positions physical education as a tool to reconcile bodily experience with contemporary technological interactions, supporting learning.

Keywords: peripheral vision; physical education; cognitive development; motor skills; technology impact.

1. Introduction

In recent decades, the advent of technology and its widespread accessibility have profoundly transformed young people's daily habits, indirectly influencing their learning capacity (Kashada et al., 2018). The constant interaction with technological devices has led to an increasing dependence on screens, resulting in progressively longer usage times (Lin et al., 2018; Pontes, 2021). This phenomenon has raised concerns among international health institutions such as the World Health Organization (WHO) and the American Academy of Pediatrics (AAP), which have established guidelines for safe screen use among adolescents, recommending no more than two hours of daily exposure (WHO, 2019; AAP, 2016). On the one hand, new technologies offer innovative learning opportunities (Sadiku et al., 2017), but on the other hand, the tendency not to adhere to these threshold limits in today's youth culture is fueling experts' concerns regarding the potential negative effects on both the physical and cognitive health of adolescents (Mark & Janssen, 2008; Onyeaka & Zhang, 2022; Lua et al., 2023). One of the first indirect consequences for physical health is the significant reduction in general motor activity and time spent outdoors, leading to decreased use of peripheral vision (Nielsen, 2021). This phenomenon results in a greater focus of visual attention on limited areas, contributing to an increasingly centralised visual focus (Sharma, 2018). Beyond its implications for visual health, this trend influences how young people perceive and interact with their environment, as well as compromising their sustained attention, necessary for detecting simultaneous stimuli without immediate focus (Alirezabeigi et al., 2022). Peripheral vision is therefore not merely a visual function but also supports global interaction with the environment, allowing for comprehensive spatial perception and the use of diffused attention to respond to external stimuli, thereby influencing learning processes (Cannon, 1986; Srikantharajah & Ellard, 2022; Stockley, 1977). Many educators, such as Piaget (1952), Montessori (1967), and Gardner (1983), have emphasised the importance of learning through physical and sensory experience, highlighting how direct contact with the environment fosters healthy development. The growing reliance on digital devices and the consequent reduction in physical experiences could negatively affect young people's physical and cognitive development, especially in learning, which is becoming increasingly disconnected from bodily dynamics. Some researchers have termed this phenomenon "disembodiment," where educational experiences become progressively less tied to physical involvement and increasingly mediated by screens (Wang & Hu, 2022; Exler et al., 2019). In this context, physical education can represent an opportunity to address this imbalance in modern youth. Promoting activities that actively involve the body and integrate specific elements, such as peripheral vision, could help mitigate the negative effects of excessive technology use. Through bodily engagement, it may be possible to re-establish a balance between mind and body (Jiménez et al., 2007; Burnat, 2015). Integrating peripheral vision into curricular motor activities could enable all students to develop a range of transversal skills, such as the ability to maintain diffused attention, which is useful not only for motor learning processes. In this regard, the Sincrony movement education methodology offers an innovative approach, integrating specific and protocol-based exercises to stimulate peripheral vision in adolescents, aiming at comprehensive training that considers the body and mind as a unified entity (De Bernardi, 2008). The Sincrony methodology proposes a motor education approach that goes beyond traditional physical activities, introducing exercises designed to engage the entire perceptual system, including peripheral vision. This methodology uses peripheral vision stimulation to enhance spatial awareness, balance, and coordination (Ambretti et al., 2023; Fogliata & Ambretti, 2023). Additionally, by fostering a connection between movement and cognitive processes, Sincrony indirectly counteracts the typical "*disembodiment*" of our era, where the body risks becoming secondary to technology. This study aims to explore whether physical education can serve as an educational strategy not only to improve adolescents' motor skills but also their cognitive abilities. The inclusion of protocols derived from the Sincrony method is motivated by its embodied approach. Thus, targeted exercises have been integrated into the school physical education curriculum, supporting the idea that the body can be a central component in learning (Kayrgozhin et al., 2022).

2. Materials and Methods

The study aimed to evaluate the effect of integrating peripheral vision training into physical education on adolescents' motor and cognitive skills. The research was conducted collaboratively between Milan and Salerno. The sample consisted of 56 participants with a mean age of 12.6 years (SD=+/- 0.8), all from lower secondary school. The first selection criterion was screen exposure time, assessed through questions based on the Questionnaire for Screen Time of Adolescents (QueST). Only adolescents with screen exposure exceeding two hours per day were included (Knebel et al., 2020). Participants were further screened to include those in general good health, without chronic illnesses or neurological issues that could impact motor and cognitive abilities. Additionally, they were required to regularly attend physical education classes but not participate in competitive sports, to avoid external influences on motor skill levels. Lastly, participants needed normal or corrected vision and a willingness to complete the three-month programme, with parental informed consent.
Participants were divided into two groups, ensuring similar mean ages and gender balance.

Experimental Group (n=32): Comprising 17 males and 15 females, with a mean age of 12.7 years (SD=+/-0.7).
Control Group (n=24): Including 13 males and 11 females, with a mean age of 12.5 years (SD=+/- 0.8).

All participants attended at least 90% of the lessons. The intervention lasted 12 weeks and was integrated into the school physical education curriculum. Both groups participated in biweekly sessions, each lasting 35 minutes. The experimental group followed a structured programme based on the Sincrony method, which included exercises designed to stimulate peripheral vision and promote bodily awareness, whereas the control group did not incorporate this integration (Table 1).

Table 1: activities conducted during the 12-week sessions.

ACTIVITY	EXPERIMENTAL GROUP (N = 32)	CONTROL GROUP (N = 24)
WARM-UP (10 MINUTES)	Anderson stretching and general coordination exercises with peripheral focus and proprioception.	Anderson stretching and general coordination exercises. No peripheral focus.
MAIN TRAINING (30 MINUTES)	Games with peripheral focus using basic tools.	Generic motor games using the same tools but without peripheral focus.
"START AND STOP"	"Start and stop" activities focusing solely on physical movement in space.*	"Start and stop" based on the same game* but without specific focus.
PAIR AND GROUP EXERCISES	Pair and group exercises with peripheral focus.	Pair and group exercises without peripheral focus.
COOL-DOWN (5 MINUTES)	Light cool-down exercises to improve bodily awareness.	Light cool-down exercises to conclude the session.

To evaluate the effects of the intervention, a series of standardised tests were administered at the baseline (T0) and after the intervention (T1).

Trail Making Test - Part B (TMT-B):

This test was used to measure cognitive flexibility and attention. Participants were required to connect a sequence of numbers and letters alternately, necessitating diffused attention rather than a focal focus on either numbers or letters to avoid time delays due to shifting (Gaudino et al., 1995; Salthouse, 2010).

Star Excursion Balance Test (SEBT):

This test assessed dynamic balance, asking participants to reach as far as possible in eight different directions while maintaining a single-leg stance (López-Plaza et al., 2018).

Confrontation Visual Field Test (VST):

This test evaluated peripheral vision capabilities by measuring the extent of the visual field (Johnson & Baloh, 1991; Kerr et al., 2010).

3. Results

The data were analysed using SPSS software. To evaluate potential within-group changes between T0 (baseline) and T1 (post-intervention), the non-parametric Wilcoxon Signed-Rank Test was applied for repeated measures on paired samples.

Trail Making Test - Part B (TMT-B)

Experimental Group: Results showed a significant reduction in test completion time ($Z = -2.97$, $p = 0.003$).

Control Group: No significant change was observed ($Z = -1.68$, $p = 0.09$).

Star Excursion Balance Test (SEBT)

Experimental Group: Improvements were not statistically significant ($Z = -1.81$, $p = 0.07$).

Control Group: No significant change was observed ($Z = -1.55$, $p = 0.12$).

Confrontation Visual Field Test (VST)

Experimental Group: A significant improvement in peripheral visual field was observed ($Z = -2.24$, $p = 0.025$).

Control Group: Changes between T0 and T1 were not significant ($Z = -1.81$, $p = 0.07$).

Between-Group Comparisons

To compare changes between the experimental and control groups at the end of the intervention (T1), the non-parametric Mann-Whitney U Test for independent samples was used.

Trail Making Test - Part B (TMT-B)

A significant difference was found between the experimental and control groups ($U = 189.5$, $Z = -2.97$, $p = 0.003$), with the experimental group showing greater improvement.

Star Excursion Balance Test (SEBT)

The difference between groups was not statistically significant ($U = 220.0$, $Z = -1.74$, $p = 0.08$).

Confrontation Visual Field Test (VST)

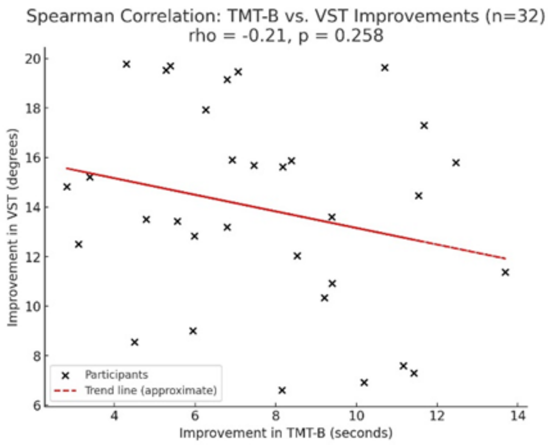
A significant difference was observed between the groups ($U = 195.0$, $Z = -2.32$, $p = 0.020$), with the experimental group achieving better results.

Effect Size (r) Calculation. Using the Wilcoxon test, the effect size r was calculated to assess the magnitude of differences between the experimental and control groups: Trail Making Test - Part B (TMT-B): □ =0.53; Star Excursion Balance Test (SEBT): □ =0.31; Confrontation Visual Field Test (VST): r=0.41

Following the significant findings for the experimental group at T1 in the TMT-B and VST, a non-parametric Spearman's rank correlation test was conducted to examine potential associations between improvements in these tests. The correlation coefficient was $\varrho = -0.21$, with $p=0.258$.

This indicates a weak negative correlation between improvements in TMT-B and VST, which was not statistically significant ($p>0.05$) (Figure 1).

Figure 1: graphical representation of Spearman Correlation.



4. Discussion

The findings indicate that the experimental group, which integrated peripheral vision stimulation into the physical education curriculum, showed significant improvements in the Trail Making Test - Part B (TMT-B) ($p=0.003$). This was reflected in a reduced average completion time, indicating enhanced sustained attention. In contrast, the control group did not exhibit improvements ($p=0.09$). The effect size calculation for the experimental group compared to the control ($r=0.53$) highlights the substantial impact of the intervention, aligning with its intended goals. Similarly, the results of the Confrontation Visual Field Test (VST) demonstrated significant improvements in the experimental group ($p<0.05$), with a greater extension of the peripheral visual field compared to the control group, which showed no significant changes ($p=0.07$). This suggests that integrating peripheral vision stimulation positively impacted the experimental group by enhancing visual perception beyond the central field. The effect size ($r=0.41$), though smaller than for TMT-B, underscores the intervention's substantial contribution. The correlation analysis between the TMT-B and VST at T1 suggested no systematic direct relationship between the results in these tests ($p>0.05$). The absence of significant correlation may indicate that improvements in the two tests did not occur in parallel. Participants who showed significant progress in one test did not necessarily improve in the other. This finding could reflect the distinct nature of the cognitive and perceptual processes involved, suggesting that the intervention may have impacted these skills differently. The weak negative correlation observed ($\varrho=-0.21$) may also point to individual variation in the benefits of the intervention, where some participants experienced more substantial cognitive improvements, while others benefited more in perceptual aspects. This lack of a direct link between improvements further highlights the multifaceted effects of the intervention. For the SEBT, while both groups showed improvements, these were not statistically significant for the experimental group ($p=0.07$) or the control group (p=0.12). The effect size (r=0.32 for the experimental group) suggested a moderate impact of the intervention on dynamic balance, though not strong enough to achieve significance. This result indicates that while the training positively influenced postural control, further studies are needed to determine the effectiveness of peripheral vision integration in more intensive or longer-duration protocols to achieve significant improvements in motor abilities.

5. Conclusions

The integration of peripheral vision stimulation into physical education has proven, in this study, to be an effective approach for improving attentional and visual abilities in adolescents. This integrative approach underscores the potential of the body to assume a central role in the learning process, mitigating the negative effects of perceptual fragmentation caused by excessive technology use. It offers a shift from a societal context often characterised by technological "*disembodiment*" which alienates young people from their physicality, to a possible educational context that could rediscover the body as a fundamental educational and didactic tool. The results demonstrated significant improvements in attention and visual perception for the experimental group following the Sincrony methodology. While the findings are promising, it would be valuable to assess these effects in a larger sample. The impact on dynamic balance was less pronounced, with no significant changes for either group, indicating the need for further investigation to fully understand the potential of this method for this parameter (Burnat, 2015). The lack of a significant correlation between attentional and visual improvements suggests that these processes may benefit from personalised approaches tailored to the individual needs of young people (Cohen & Haith, 1977). In the context of the technological era, physical education holds immense potential to balance digital interaction with specific bodily activity. Strategies that integrate peripheral vision stimulation and promote diffused attention could contribute to balanced development. It would be interesting to analyse these aspects in a follow-up study and, more broadly, in line with pedagogical theories advocating for the importance of bodily experience in holistic development. Further research should investigate the body as a primary tool for students, aiming for more comprehensive and balanced learning outcomes (Cojanu, 2017).

6 Informed consent and declaration of conflicts of interest

All legal guardians provided written informed consent prior to the school's participation in the study. The procedures followed adhered to the ethical standards outlined in the Declaration of Helsinki. Confidentiality of participants' personal data was ensured, and all collected information was used exclusively for research purposes under anonymity. The authors also declare that there are no financial or personal conflicts of interest that could have influenced the results presented in this manuscript. This includes any professional or financial relationships with commercial organisations that could be perceived as potential influences on the research data.

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