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Original Article

Enhancing children's motor creativity: A methodological pilot study

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Abstract
Motor creativity is widely recognized as a component of physical literacy, encompassing the ability to adapt movement by generating original and functional solutions to motor challenges in dynamic environments. Positive challenges that encourage exploration and the discovery of action possibilities can promote enjoyment while providing physical and sport-related benefits. Accordingly, the primary aim was to examine the effectiveness of a motor creativity program in enhancing cognitive and motor creativity among young gymnasts as well as their self-efficacy and enjoyment. Thirty-four beginner gymnasts (5–8 years), participated in this study and based on their availability to participate in the additional weekly lesson they were divided into experimental and conventional group. The first one attempted to an experimental training program for 2-month. Before and after the intervention, Bertsch's Test of Motor Creativity (1983), Torrance Test of Creative Thinking (TTCT; Torrance 1988), Physical Activity Enjoyment Scale and Self Efficacy questionnaire (Morano et al. 2019) were administered. Separate repeated-measures Intervention × Time ANOVAs examined whether creative intervention group, compared to traditional one, showed pre–post changes in motor creativity, creative thinking, PA self-efficacy, and PA enjoyment. A repeated-measures Intervention × Time MANOVA was applied to motor creativity dimensions (fluency, flexibility, originality). Results showed that experimental group showed significant improvements in overall motor creativity, as well as in fluency and originality. Additionally, only the experimental group showed a significant increase in enjoyment. This study underscores the necessity of adopting nonlinear methodological approaches in both educational and sporting contexts to foster the development of creative potential, which is fundamental to the process of physical literacy.
Key words: Motor creativity, Physical literacy, Creative thinking, Self-efficacy, Enjoyment

Introduction

The decline in physical activity (PA) from childhood through adolescence is a global trend with significant consequences for both immediate and long-term health and well-being (WHO,2024). Despite an improving of strategies and action plans to promote best practices (WHO,2023), at the present interventions planned to counteract physical inactivity in children and adolescents still seem to be of little impact in promoting significant behavioural changes (Till et al., 2025). This may be because most physical activity approaches prioritize health outcomes over understanding why children and adolescents choose to move (Houser & Kriellars, 2023). From a developmental perspective, there is an ever-increasing need to restructure educational practices and outcomes in physical activities looking beyond the context of movement skill (Cairney et al., 2019). Not all children enjoy doing physical or sports activities, and it can occur that movement experiences do not inspire a sense of competence and confidence (Cairney et al., 2016). A deeper understanding of children's perspectives on meaningful physical activity reveals that immediate enjoyment, fun, and social interaction are key drivers for participation (Bingham et al., 2025). The sense of freedom in both thought and movement, along with the enjoyment and fun experienced when engaging with others, are the most influential factors shaping children involvement (Bingham et al., 2025). Children are naturally oriented toward growth and integration, they seek to learn, actively participate in the world, and connect with others. This human orientation toward learning, relationships, and socialization can occur through/within movement experiences and physical activity (Ryan & Deci, 2017). The topic for understanding these needs related to movement is provided by the concept of physical literacy (PL), which emphasizes the development of motivation, confidence, physical competence, and knowledge that individuals develop in order to maintain physical activity at an appropriate level throughout their life (Whitehead, 2010). Physical literacy is a multidimensional concept which includes understanding movement as an essential condition of human experiences (Cairney et al., 2019). Beyond physical activity (PA) alone, physical literacy process seeks to foster a lifelong relationship with movement by integrating physical, psychological, social, and creative domain (Houser & Kriellars, 2023; Agans et al., 2024). The development in each of these domains occurs in integrative and cumulative manner across all the movement contexts in which the individual engages (Agans et al., 2024). Thus, recent frameworks are focused toward individualized, inclusive and holistic process that would allow encounters in non-linear pedagogy (NLP) grounded on ecological dynamics (Houser & Kriellars,2023; Valadi et al., 2025). NLP emphasizes the continuous interaction between

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individuals and their environments and encourages their autonomy (Valadi et al., 2025). From this perspective, fostering creativity throughout an exploration-based approach addresses the growing demand for more enriching and holistic physical activity interventions.

Motor creativity is increasingly recognized as a central component of physical literacy as an indicator of adaptive motor behaviour, stimulated and enhanced by the exploration and discovery of original and functional solutions to motor tasks in dynamic environments. This ability promotes the generation of novel, original, and functional motor patterns, often in response to open-ended tasks (Ourda et al., 2025). Motor creativity supports the solving of pre-existing problems or the expression of ideas or emotions through the human body (Bournelli et al., 2009; Torrents et al., 2021; Wyrick, 1968). The role of creativity in movement is supported by numerous studies highlighting its associations with physical competence (Torrents Martín et al., 2015), psychological factors such as open-mindedness and risk-taking, and social factors such as trust and vulnerability (Richard et al., 2021). From a developmental perspective, several issues are particularly important for understanding and fostering motor creativity. First, it is essential to deepen our understanding of the relationship between motor creativity and broader creative thinking processes (Scibinetti et al., 2011; Torrents et al., 2021). Furthermore, if motor creativity may contribute to the development of physical literacy (Rudd et al., 2020) its connections with psychological variables (e.g., self-efficacy) and affective factors (e.g., enjoyment) have to be carefully examined (De Pero et al., 2022; Richard et al., 2018).

Motor creativity is differentiated by other creative domains for the integration of cognitive processes with physical actions, where the body serves as both the medium and product of creative expression. (Torrents et al., 2021). It is less about translating ideas into action and more about creative behaviour emerging from action. From a neuroscientific perspective, Dietrich's (2019) framework distinguishes three different types of creativity based on consolidated concepts in cognitive psychology and neuroscience: a deliberate mode, a spontaneous mode, and a flow mode. Deliberate and spontaneous modes of creativity are supported by distinct neural networks involving different brain areas. The flow mode is a state of engagement that does not require higher cognitive control and it can be activated when a learner, consciously focused on an exploratory task, perceives action opportunities in the environment that trigger sensorimotor processes. In this sense, flow can be seen as creativity in motion occurring during the flexible exploration of multiple motor solutions in real time. Indeed, the flow mode fuses perception and action, a fluid and rapid integration of sensory inputs and motor outputs during open-ended tasks, (Dietrich, 2019).

Children's motor creativity has been positively associated with psychological well-being factors (Theodorakou & Zervas, 2003; Bournelli, et al., 2009). For instance, Theodorakou and Zervas, (2003) showed that fostering creative movements in children could increase general self-esteem and led to more positive perceptions of scholastic, social, and athletic competences. Likewise, children exhibiting higher perceived social acceptance and physical competence scored higher in movement creativity tasks (Bournelli, et al., 2009). These findings pointed out the idea that motor creativity might contribute positively to psychological adaptability where the degree of adaptation is a function of the difference between how one perceives the environment/task (e.g. challenging, threatening etc.) and how one perceives his/her own ability/capacity (i.e., self-efficacy) (Richard et al., 2018).

Research consistently underscores the pivotal role of physical activity enjoyment as a determinant influencing children's sustained engagement in physical activities (Binghman et al., 2025). Creativity (supported by executive functions such as cognitive flexibility) influences how individuals interpret and engage with physical activity. This cognitive framing shapes affective responses (e.g., enjoyment, interest, perceived challenge). Positive emotional mood during activity is a well-established predictor of future engagement in physical activity. Therefore, creativity may indirectly promote sustained physical activity through its effect on affective experience (Jung et al., 2021).

While research on non-linear pedagogy (Richard et al., 2018; Asadi et al., 2023; Houser & Kriellaars, 2023) and motor creativity is growing in school settings (Richard et al., 2018; Tocci et al., 2022; Ourda et al., 2025), in sport domain it is mainly examined in open skill sports with particular focus on tactical creativity (Memmert et al., 2010; Rasmussen & Østergaard, 2016; Santos et al., 2017). Investigating motor creativity in youth sports settings is crucial because sport environments account for a significant share of children's total physical activity time; the possibilities for creativity in sport should not lie in refining performance efficiency but in designing learning environments that legitimize uncertainty and exploration (Rudd et al., 2020). Unfortunately, an overemphasis on repetition and early specialization within closed-skill disciplines, such as gymnastics, can inhibit children's behavioural exploration, thereby stifling motor creativity instead of promoting it. Accordingly, within closed skill discipline, promoting alternative training frameworks, such as non-linear pedagogy, could be essential for eliciting creative behavioural adaptations.

Thus, the primary aim of this study was to verify whether a theory-based motor creativity program, grounded on non-linear pedagogy and constraints-led approach (Richard et al., 2018; Scibinetti, 2019; Tocci et al., 2022) could support children's motor creativity. This intervention program was applied to a *closed-skills sport domain* (artistic gymnastics), because it is founded on linear and reproductive approach, far from divergent methodological approach. Furthermore, because cognitive and motor creativity may exhibit different developmental trajectories and underlying mechanisms (Pesce et al., 2025), our interest was also aimed to verify

whether enhancing creative motor experience through the intervention program would foster creative thinking as well. We hypothesize that exploratory behaviours promoted by motor creativity programs are linked to the *flow mode* of creativity (Dietrich, 2019) and may not directly engage higher cognitive processes. Finally, because enriched movement repertoire provides gymnasts more options to overcome motor challenges, positive changes in self-efficacy and enjoyment were expected for the gymnasts participating in the creative program.

Material & Methods

Participants

This pilot study involved 34 female gymnasts aged between 5 and 8 years old (sd= ± 1.3) engaged in a beginning course of artistic gymnastics in Rome. All participants were with no reported neurological, motor or developmental disabilities. All gymnasts attended basic artistic gymnastics courses. Based on gymnasts'availability to participate in the additional weekly lesson, as required by the trial's training protocol, they were divided into two groups: the creative program group (N= 16) and the traditional program group (N=17). To minimize potential confounding effects reflecting additional practice, additional contact with coaches, self-selection or some combination of these factors, all gymnasts attempted an equivalent number of weekly training hours. Specifically, the traditional program group followed an enhanced training schedule to match the total weekly training hours of the creative program group.

Approval from the association's president and board of directors was required. Parents and guardians were provided information on the aim of the study with a plain language description and a consent form, specifying that participation was not mandatory and that gymnasts could withdraw at any time without having to provide a reason. According to Italian Gymnastic Federation rules, gymnasts were required to have a medical certificate. The internal ethical committee of the University of "Foro Italico" approved the protocol employed (66/2020). The Association's president and students'parents gave written informed consent. This study was conducted in accordance with the Declaration of Helsinki.

Measures and scoring

Motor Creativity

Children's motor creativity was assessed with the Bertsch's test (1983). This test is composed of four tasks to be performed individually, in randomized order on the floor, with a bench, a hoop or a ball, respectively. The tasks are offered in two versions—Form A and Form B—differing in movement freedom: Form A leaves performance unspecified, while Form B partially defines it. In this study, the floor and bench tasks from Form B were used because they require gross motor coordination in line with the children's developmental stage and are closely linked with gymnastics objectives.

For the Floor task, two parallel lines were located to delimit a 2.5 metres area on the floor. The verbal instruction was: "Your task is to move from one line to the other. You are free to do anything you want between these two lines. Show me all possible ways you know or that may come to your mind to do that." For the Bench task, it was positioned in the middle of a room, with two hoops positioned at the two ends of the bench representing the starting and arrival point. The verbal instruction was: "You have to go from one hoop to the other and back, keeping a part of your body always in contact with the bench." The floor task lasted 2 minutes and 30 seconds and 3 minutes for the bench task with a total test duration of about 10 minutes including the initial instruction and breaks between tasks (Scibinetti et al., 2011; Tocci et al., 2022).

During each task, children motor behaviours were video recorded and subsequently coded and scored. Data coding consisted in assigning scores on three dimensions: fluency, flexibility, and originality. Fluency was scored in terms of the number of different behaviours displayed by the child during each motor task. Flexibility and originality were coded and scored based on Bertsch's (1983) normative data. Flexibility was scored referring to movement behaviour categories identified by Bertsch for each task: 44 for the bench task, and 36 for the floor task. Such categories summarize motor behaviours as a function of body position, movement direction and type. The flexibility score was the sum of movement categories, identified as a function of body position, movement direction and type, for which at least one behaviour was observed, categories with two or more observed behaviours being counted only once. Originality was quantified assigning a score ranging from 0 (low originality) to 3 (high originality) to each behaviour in each category based on the relative frequency of such behaviour in Bertsch's normative sample. To obtain a total score for each creativity dimension, scores for the four tasks were standardized and averaged. Furthermore, a grand average of creative thinking at pre and post-test was computed by merging the three creative thinking variables.

Creative Thinking

Torrance Test of Creative Thinking (TTCT), Figural Form A (Torrance, 1988), designed for individuals in kindergarten through graduate school and beyond, was group administered. It consists of three timed pencil and paper picture construction and completion activities lasting 10 min each with 1 min break between tasks for a total working time of about 30 min. The first Activity was a Picture Construction: children had to construct a picture using a darkened curve shape (jellybean or teardrop) provided on a page as a stimulus to be integrated in the picture construction. The second activity was a Picture Completion: children were asked to use 10 incomplete figures to create drawings of objects or figures, avoiding conventional or obvious completions. The

last activity named Parallel Lines: children had to use 30 pairs of straight lines drawn on three pages to make an original picture out of each pair of lines. Pictures were coded and scored on three sub-scales of norm-referenced measures: fluency, flexibility, and originality. Fluency was scored by the number of figural images produced by the child; flexibility by the variety of categories of relevant responses; and originality by the number of statistically infrequent responses based on normative data (Torrance, 1988). Raw scores were converted into standard scores to have comparable ranges for fluidity, flexibility, and originality. Furthermore, a grand average of creative thinking at pre and post-test was computed by merging the three creative thinking variables.

Self-efficacy in physical activities

The pictorial version of the self-efficacy in physical activities inventory (Morano et al., 2019) was used to assess gymnasts' self-efficacy. Thanks to modified items represented with emoticons and pictograms, it renders the scale more easily understandable by younger children and helps them grasp the meaning of the items. Item scores ranged from 1, indicating low efficacy (e.g., 'I run slow') to 4, representing high efficacy (e.g., 'I run very fast'). The total score of the self-efficacy questionnaire was obtained by the sum of the scores of the four items giving a possible range from 4 to16 points.

Enjoyment in physical activities

We used four items (Morano et al., 2019) selected from the Physical Activity Enjoyment Scale (PACES; Carraro, et al. 2008), a 16-item scale designed to assess the enjoyment of physical education classes among students aged 11 to 19. The scale was slightly modified by associating the items with emoticons to make them easier for children to understand (see Scales S1). Item scores ranged from 1 (not at all) to 5 (very much). In both scales (self-efficacy and enjoyment), participants were asked to think about themselves during gymnastics class. They were then asked to indicate the response for each item that best represents their personal feelings.

Experimental Protocol

Two coaches agreed to participate in the creative training program, and they were given 8 hours of training about strategies leading to optimal behaviours to promote creativity in children. They then practiced implementing the program and received feedback from a creativity development expert. The intervention was performed in the gym of the association for 1 hour once a week and lasted 2 months from February to April 2025 with a total amount of 8 intervention hours divided into 6- teaching modules. The experimental group consisted of 16 gymnasts who performed the creative motor program in addition to usual weekly artistic gymnastics classes. The decision to add the experimental creativity training was necessary to avoid interfering with the core program that both groups were required to follow throughout the year.

Two testing sessions were organized before and after the 2-month intervention. Testing sessions took place during the exercise class. During the first session, gymnasts were asked to complete the Creative thinking test in Figural Form and the self-efficacy and enjoyment questionnaire. For the second testing session, they performed individually the two motor creativity tasks in a random order and in an isolated place. The same protocol was used for the post-test.

Traditional program

The traditional program is based on principles and techniques designed to improve gross motor skills, flexibility, posture, strength, balance, and coordination to develop in young gymnasts pre-requisites useful to future challenges in a linear manner. The teacher adopts a Reproduction Teaching styles (e.g., command, and practice) that are mainly based on learning by imitation of models of movement (Mosston & Ashworth, 2008).

Motor creativity intervention

The intervention was designed in line with the principles of non-linear pedagogy, based on a constraints-led approach. Non-linear pedagogy has shown a significant impact on the development of creativity through the systematic manipulation of constraints, understood as boundaries within which learners can explore and search for movement solutions within a perceptual-motor workspace (Chow 2013; Orth et al., 2017). Constraints can be grouped into three categories: personal (abilities, motivation, beliefs, culture), environmental (temperature, social support, peer pressure), and task-related (goals, rules, instructions, equipment) (Torrents et al., 2021). The search for original and functional movement solutions involves exploratory behaviours that emerge through interaction with dynamic environments (Hristovski et al., 2011). Because open-ended tasks take place in constantly changing conditions that require continuous real-time adaptation, improvisation plays a crucial role in these exploratory processes. It supports the emergence of innovative movement patterns and encourages open-ended exploration within specific task constraints. (Perez-Calzado et al., 2026). Thus, a Divergent Discovery Teaching style (Mosston & Ashworth, 2008) was adopted by teachers involved in the intervention as more appropriate to encourage original and functional solutions involving decision-making process and focusing on cognitive, social, and personal development. The teacher embraces the role of facilitator through the intentional manipulation of environmental and task constraints. The activities are presented as open-ended tasks, designed to require effort, include clear goals, and provide immediate feedback. Since many different solutions are accepted, as long as they are consistent with the intended objective, each child can explore their own solutions based on their level of motor competence. Teacher provides neutral feedback acknowledging that their responses are acceptable and encouraging them to continue looking for new solutions, suspending judgment. Teacher only provides corrective feedback if the students move away from the open-ended task. In line with the main

objectives (early artistic-gymnast) based on improving of gross-motor skills, posture and spatial temporal orientation, open-ended tasks were designed with specific target such as enhancing body's knowledge, spatial-temporal orientation, posture and balance and promoting collaborative exploration. Each session was divided into three parts: activation, central phase, and cool-down/final game, all related to the topic covered. Creative activities are presented both in pairs and in small groups to improve cooperation and inclusive social behaviours (Lobo & Winsler, 2006). The activities were developed with an appropriate music in the background which promoted movement exploration. To ensure implementation fidelity but also an adequate degree of adaptability, teachers in the experimental group used a handbook, which describes the pedagogical principles and the PA activities designed to foster motor creativity (Scibinetti, 2019). Manipulations of tasks and environmental constraints were presented by improving the same objective/theme with other coordination's requests.

At the beginning, the creative program focused on body parts awareness, a key milestone in fundamental motor skill. Specifically, task constraints were used to encourage participants to explore new ways of moving, using different body parts, in pairs and staying on the ground (e.g. *Hermit crab* activity). Then, environmental and task constraints were used to improve the relationships between body parts. Body parts can be positioned in different relationships with one another (e.g., together or apart, up or down, near or far, forward or backward, and in similar or opposing configurations). Furthermore, different shapes offer affordances that encourage the exploration of novel movement patterns (e.g. *Sculptures and Obstacles* activity*)* (*Table 1*).

Table 1.
Example of creative activities with constraints-led approach

Aim of the activity – Knowledge of body The activity aims at stimulating the perception and knowledge of different body parts, by using the metaphorical imagine of the Hermit crabs. Children in pairs, were stimulated to move on the ground exploring new ways of movement generated by the different body parts in contact.	**Aim of the activity - Knowledge of body in relation to spatio-temporal orientation** The activity aims at improving the ability to inhibit routine behaviours adopting new and different solutions a) to invent many different shapes with the body parts and b) to find different solutions to cross over the changing shapes of the body. Perceptual-motor adaptation abilities (e.g. spatial-temporal orientation) were involved.
Activity *Hermit crabs* In pairs with a part of body in contact, on the ground, try to move by changing the body part in contact, just as the hermit crab moves with its shell. Imagine moving in the sea, on the rock or on the beach. Every time the hermit crab moves, the shell will adapt to follow it, also changing the part of the body in contact.	**Activity: *Sculptures and Climbers*** Children are assigned into two role-groups: sculptures and climbers. The teacher asks the children to run around freely, so the groups are mixed. At the signal, all children-sculptures stop and invent a shape with all body parts (upright position or on the ground) while the other children (climbers) explore different solutions to pass *only under* the shape-sculptures. Depending on the shapes of the body parts, it will be possible to choose different spaces to pass under it each time (e.g. under an arm, leg, pelvis). At the teacher's signal, all children moving freely and then repeat the activity: each time the sculptures change their shape.
Task constraints • Teacher names the body part in contact. • Some equipment is required in the gym (e.g. bench, gym mat) to involve opportunity for action in the environment.	**Task and environmental constraints** • Ask the climbers to climb *only over* the shape. • Let children choose how to pass through each sculpture. • Ask the sculptures to become a *live sculpture*: children move the shape with *one* simple action (opening and closing their legs; roll on the ground). As consequence climbers must choose adaptive motor behaviour to cross the live shape without getting trapped.

Data analysis

A power analysis was conducted using GPower (version 3.1) to determine the adequacy of the sample size of the study. The analysis was based on a repeated-measures ANOVA with a between-group factor (2 groups) and a within-subjects factor (2 repeated measurements). Assuming a medium effect size ($f = 0.30$), a significance level of $\alpha = 0.05$, and statistical power of .90 the required sample size was 32.

The statistical analyses were mainly focused on the possible effects of the different interventions (traditional Vs Creative) gymnasts participated across two months period upon their Motor Creativity and Creative thinking; Self-Efficacy and Enjoyment in Physical Activity (PA).

More specifically a series of separate repeated measures Intervention by Time ANOVAs were performed to assess whether gymnasts who participated in the creative intervention sessions reported, as compared to gymnasts of the traditional intervention, significant changes across pre-intervention and post-intervention

measurements, respectively, in their Motor Creativity and Creative Thinking, Self-Efficacy in PA, Enjoyment in PA. Finally, an additional repeated measures Intervention by Time MANOVA was also performed considering the different components of motor creativity, namely the fluency, flexibility, and originality. The analyses were performed using SPSS version 30 (IBM, 2024).

Results

Motor Creativity

With respect the gymnasts' Motor Creativity the results of the ANOVA showed a significant effect for the interaction between the Intervention and the Time considering as dependent variable the total score of motor creativity test ($F_{(1,31)}$ =5.776; p=.022; Partial eta squared=.157). More specifically, as showed in Figure 1, the gymnasts of the creative group intervention showed an improvement in their motor creativity while the gymnasts of the tradition intervention a decrement.

With respect the MANOVA performed considering the three different components of the Motor Creativity emerged a very close-to-significance multivariate effect for the interaction between the Intervention and the Time (Wilkins'Lamda $_{(3, 29)}$ =.770; p=.052; Partial eta squared=.230).

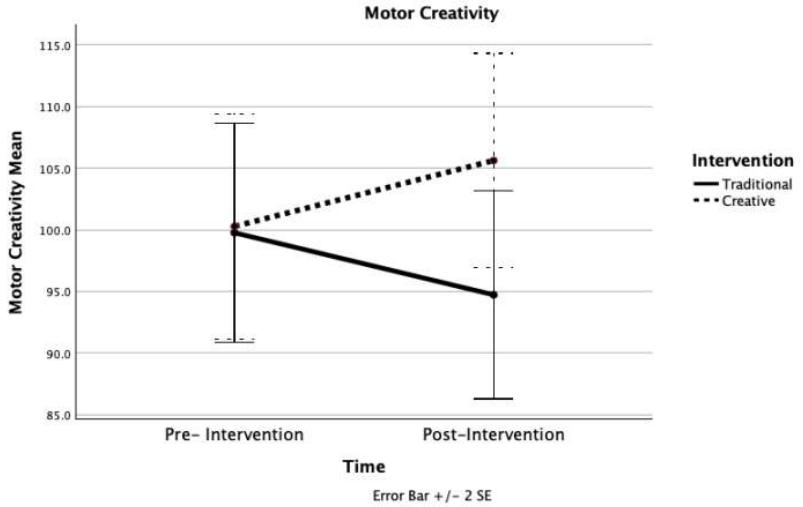
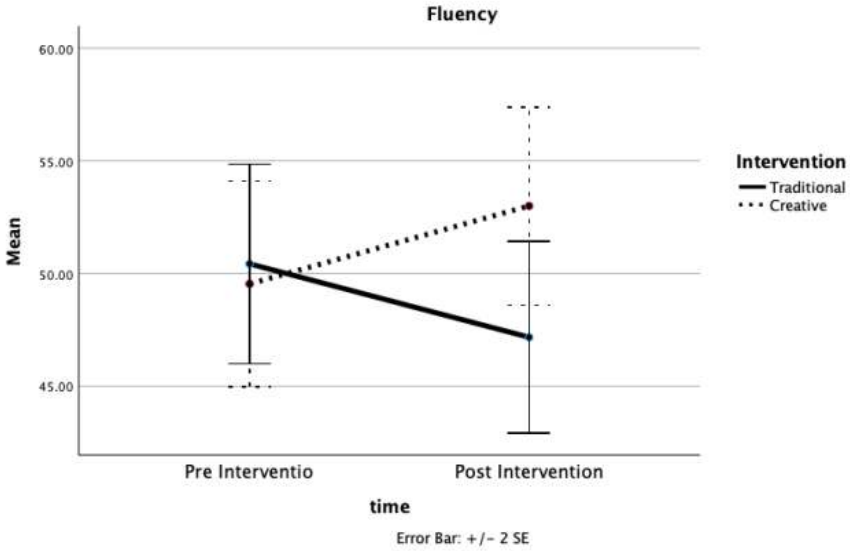


Fig 1. *Total Motor Creativity across time for gymnasts of traditional and creative intervention*

Considering the univariate effects, the ANAOVs showed a statistically significant effect of the InterventionXTime interaction for Fluency ($F_{(1,31)}$ =6.950; p=.013; Partial eta squared=.183) and Originality ($F_{(1,31)}$ =4.308; p=.046; Partial eta squared=.122) and not for flexibility ($F_{(1,31)}$ =1.197; p=.282; Partial eta squared=.037). As reported in Figure 2 the gymnasts of the creative intervention group reported over time a statistically significant improvement in both Fluency and Originality components of the motor creativity, while the gymnasts of the traditional intervention showed a decrement in the same time frame.



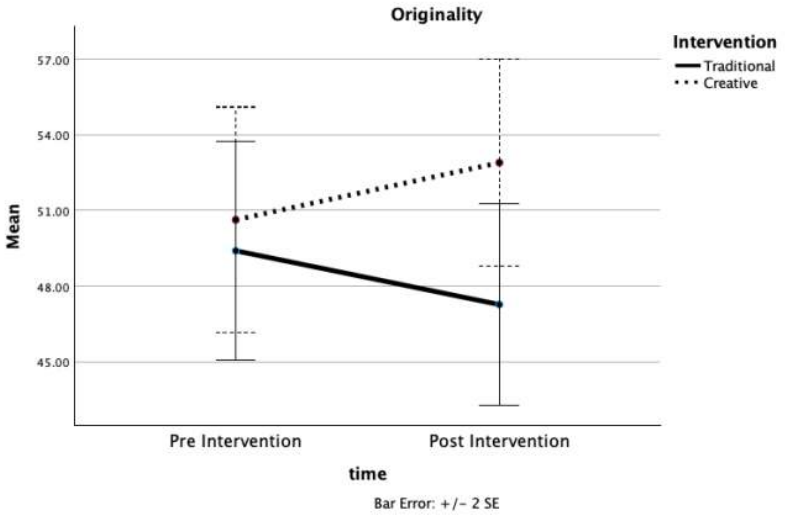


Fig 2. *Fluency and Originality dimensions of Motor Creativity across time for gymnasts of traditional and creative intervention*

Creative Thinking

The results of the ANOVA showed no significant effect for the interaction between the Intervention and the Time ($F_{(1,31)}$ =1.006; p=.324; Partial eta squared=.031) neither a main effect of the Intervention ($F_{(1,31)}$ =1.005; p=.324; Partial eta squared=.031) or of the Time ($F_{(1,31)}$ =.001; p=.976; Partial eta squared<.001). Even the pairwise comparisons showed no significance effect for the time both in creative intervention group gymnasts ($F_{(1,31)}$ = .488; p = .049; Partial eta squared=.015) and in gymnasts of the traditional intervention ($F_{(1,31)}$ = .518; p = .477; Partial eta squared=.016).

Self-efficacy in physical activities

The results of the ANOVA showed no significant effect for the interaction between the Intervention and the Time ($F_{(1,31)}$ =.271; p=.606; Partial eta squared=.009). However, a detailed examination of pairwise comparisons yielded a close-to-significance effect among creative intervention group gymnasts ($F_{(1,31)}$ = 3.28; p = .08; Partial eta squared=.096) whereas this pattern did not emerge for the gymnasts of the traditional intervention ($F_{(1,31)}$ = 1.25; p = .27; Partial eta squared=.039). More specifically, creative intervention group gymnasts showed a more improvement in their self-efficacy over time (Mean $_{time\ 1}$ = 11.69; SD $_{time1}$ = 1.92; and Mean $_{time\ 2}$ = 12.38; SD $_{time\ 2}$ = 1.63) with respect the gymnasts of the tradition intervention (Mean $_{time\ 1}$ = 12.65; SD $_{time1}$ = 1.90; and Mean $_{time\ 2}$ = 13.306; SD $_{time\ 2}$ = 2.30).

Enjoyment in physical activities

The results of the ANOVA showed no significant effect for the interaction between the Intervention and the Time ($F_{(1,31)}$ =.255; p=.12; Partial eta squared=.076). Even for this variable, a detailed examination of pairwise comparisons yielded a significance effect for creative intervention group gymnasts ($F_{(1,31)}$ = 5.69; p = .023; Partial eta squared=.155) whereas this pattern did not emerge for the gymnasts of the traditional intervention ($F_{(1,31)}$ = 0.27; p = .87; Partial eta squared=.001). Over time, creative intervention group gymnasts showed a significant improvement in their enjoyment for physical activity (Mean $_{time\ 1}$ = 18.81; SD $_{time1}$ = 2.01; and Mean $_{time\ 2}$ = 19.69; SD $_{time\ 2}$ = 0.60) while the gymnasts of the tradition intervention showed no substantial changes across time (Mean $_{time\ 1}$ = 19.06; SD $_{time1}$ = 1.09; and Mean $_{time\ 2}$ = 19.12; SD $_{time\ 2}$ = 1.32).

Discussions

From a developmental perspective, the importance of engaging children and adolescents in movement activities is increasingly recognized (WHO, 2023). Within this framework, *physical literacy* emerges as a holistic process that supports lifelong participation in physical activity. This developmental pathway can be further enriched through the integration of the creative domain, which fosters expression, adaptability, and deeper engagement in movement experiences in physical education and early sport context.

The aim of this study was to investigate how a creative intervention program founded on non-linear pedagogy and constraints-led approach (Orth et al., 2017; Scibinetti, 2019; Torrents et al., 2021; Tocci et al., 2022) could support motor creativity in young gymnasts. In addition, we aimed to investigate whether the intervention could also enhance self-efficacy and enjoyment, as well as its potential association with creative thinking (Richard et al., 2018; Scibinetti et., al 2011; Tocci et al., 2022).

Motor creativity total score showed a significative improvement in creative group in line with previous findings (Chatoupis, 2013; Richard et al., 2018; Tocci et al., 2022); this group exhibited significant differences in fluency and originality dimensions with a trend towards significance for flexibility. This suggests that gymnasts

exposed to the creative training were able to use improved motor skills to explore and produce multiple and original movement solutions. The significant increase in fluency (many different motor solutions) shows how the enriched motor experiences had an impact on the greater number of motor behaviours generated (Milić, 2014). At the same time, the creative activities in experimental training, strongly focused on exploring unusual movement patterns, generated significantly original responses. Because gymnasts in the creative program were encouraged to explore and to perform under improvisation during the training session, this may have lowered their inhibition, resulting in higher original scores (Richard et al., 2018). Flexibility improved but not significantly probably because the ability to shift from one movement category to another would have required a longer exploration time than that experienced in this study.

In the present study, the significative gain in motor creativity in experimental group did not correspond to improvements in creative thinking. Consistent with previous studies (Richard et al., 2018; Tocci et al., 2022), our findings suggested a potential positive effect of the intervention on originality of thinking, although the effect did not reach statistical significance. To become creative in moving, children seem not to require an enhanced efficiency of those cognitive processes that allow them to think divergently. These results seem to sustain that creativity in movement is not the outcome of ideas generated by a creative cognitive system but emerge in the act (Orth et al. 2017), through a *flow mode* founded of the perception-action coupling without any conscious control and creative thinking effort (Dietrich, 2019). Similarly, the benefits for creative thinking associated with movement-based creative experiences are widely documented in embodied cognition research, which shows how sensorimotor processes fundamentally support creative thinking. (Matheson & Kenett, 2020). Motor activation enhances the ability to explore novel possibilities and generate adaptive solutions, suggesting that physical movement experiences may serve as a foundation for developing creative capacities that extend beyond the motor domain itself (Matheson & Kenett 2020).

Our expectations of improvements in self-efficacy after creative intervention were partially met. According to Richard et colleagues (2018), but in contrast with previous studies (Bournelli et al., 2009; Theodorakou and Zervas, 2003), our results indicate a moderate but no significative association between motor creativity and self-efficacy. We hypothesize that the questionnaire, which included both written and pictorial items, may have led gymnasts to overestimate their self-perception, also considering that this sport activity even if only practiced as amatorial activity *per se* produces positive effects on the self-efficacy as reflected in the high baseline self-efficacy levels observed in both groups.

After the intervention the role of motor creativity in sustaining children's enjoyment was confirmed by a significative improvement of this variable only in the experimental group. This important finding can be explained in terms of methodological aspects adopted in this study: first, in embracing a discovery divergent teaching style, the teacher suspends judgment with children that feel they can experiment, make mistakes, and invent their own solutions. Therefore, their increased engagement generated by a supportive environment could foster positive emotions such as enjoyment. Furthermore, creative activities which were mainly presented in pairs and in small groups could have led to better cooperation and inclusive social behaviours. Playful engagement expressed through the creative activities in group are more likely to generate creative movement and fosters peer acceptance, positive climate and fun (Ourda et al., 2025). Finally, if children experience moments of joy and satisfaction during creative activities, they foster an intrinsic desire to partake in additional endeavours (Bingham et al., 2025).

Present findings hold significant implications for future research. To move steps forward in this direction educators and trainers should intentionally integrate activities that allow children to move divergently. Founded on non-linear pedagogy and constraints led-approach intervention program not only increase motor creativity (Richard et al., 2018) but also provide opportunities for children to cooperate and to enjoy which are physical literacy key processes (Rudd et al., 2020). The practical implications of this work emphasize the need to explore and to promote creative potential within physical and sporting activities, given its contribution to children's motor, social, and emotional development. In fact, Garaigordobi, and colleagues (2022), suggested that fostering motor creativity in children contributes significantly to their social–emotional growth and enhances essential skills such as empathy, emotional stability, communication and cooperation skills, self-concept, and peer image which can contribute to long-term adherence to physically active lifestyles.

Conclusion

Motor creativity is increasingly recognized as a key resource for reinterpreting children's natural need of movement. The current decline in motor skills and the reduction of deliberate play raise important methodological challenges: interventions should be redesigned to place less emphasis on physical performance and efficiency, and greater focus on fostering enjoyment and engagement in movement. In this perspective, promoting programs grounded in nonlinear pedagogy, through the promotion of motor creativity and exploratory movement experiences, can represent a gateway to physical literacy (Rudd et al., 2020). Encouraging children to explore movement opportunities and engage in problem-solving processes could trigger positive developmental cascades on all dimensions of physical literacy such as physical, motor, psychological and social well-being from childhood through adolescence (Cairney et al., 2019; Rudd et al., 2020). This approach is consistent with evidence suggesting that physical education interventions emphasizing enjoyment, autonomy, and inclusivity are

more likely to promote sustained participation. (Habyarimana et al., 2025). As we navigate the intersection between health and performance-oriented models and development-oriented models, we should not forget our effort to developing physically literate children and adolescents who can engage confidently and creatively in lifelong physical and sport activity. Further interventional research is indicated to better examine the impact of movement exploration programming on the movement creativity and physical literacy of children.

Limitations

Several limitations should be considered when interpreting the findings. First, the sample was small and included only a female group aged 5-8 years from a single club. Future research is needed to examine whether there is a close interrelation between developmental trends in motor creativity across different age, gender, and levels of expertise. Additionally, this study focused on a short-term intervention program to avoid interfering with the artistic gymnastics training schedule. Nevertheless, the encouraging results observed in the experimental group, in terms of both motor creativity and enjoyment, suggest that future research could be implemented within sports settings without hindering the objectives of the discipline, but rather enhancing children's creative potential.

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During the preparation of this work the Authors declare that no AI tools were used.

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