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ORIGINAL ARTICLE

Study on the performative effects of cause-based vs effect-based teaching in adolescent athletes: Evaluation of lower limb explosive strength

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ABSTRACT

Purpose Understanding how humans generate movement is a fundamental goal due to its implications. The authors based their study on the methodological applications in sports of the Synchrony Theory. (DeBernardi, 2008; in press Fogliata et al., 2023) In paradigm, the perceived movement corresponds to an Effect-Movement. The motor teaching of a gesture based on the Effect can be defined as Effect-based Teaching (EbT). Motor teaching based on the visible movement of a gesture can be defined as Effect-based Teaching (EbT). While teaching based on what caused the gesture can be called Cause-based Teaching (CbT). Methods. authors aimed to evaluate the possible differences in explosive lower limb strength in the Sargent Test among adolescents instructed through these three models of demands. Results. All athletes were subjected to all three types of tests. The data showed that teaching based on Causes allows improvement of the entire group and two-thirds of the participants significantly compared to Effects-based teaching. Technical teaching also had a better outcome than Effects-based teaching, but only for a third of the sample. Conclusion. Teaching based on Causes seems to be an excellent tool for increasing performance, simple to apply and effective, allowing for instant improvement.

Keywords: Physical education, Cause-based teaching (CbT), Effect-based teaching (EbT), Internal attention, Sargent Jump Test, Performance analysis of sport.

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INTRODUCTION

Scientific studies have examined the effects of attention on motor performance and learning, stating that when athletes focus on bodily sensation rather than on an external goal, they improve their performance and technical learning (Wulf and Shea, 2002). Results suggest that attention to muscle action or movement information is important for motor control and motor learning, highlighting the importance for sports coaches to understand how to guide the athlete's attention, especially during the learning phase (Langer and Moldovean, 2000; Schmidt, 1991).

Based on the Synchrony movement model and the results obtained in a previous study on running (Debernardi, 2008; Fogliata et al., 2023), the authors suggest that it is possible to distinguish between primary muscles that give rise to the action (Causanti) from those used in the resulting movement itself (Effettori). Ivanenko and colleagues in 2004 focused on how the origin of movement, in that case of gait, should be considered based on propulsion (cause) rather than the heel strike event or stride length (effect) (Ivanenko et al., 2002). If this were the case, the authors presume the possibility that there may be different responses not only if the athlete's attention is internal versus external but also if it is placed on the Causes rather than on the effects of the action to be generated.

The authors thus created a paradigm for evaluating performance in adolescents by providing them with instructions based on the causes, rather than on the effects or technical explanation. The evaluation study chose to assess female athletes, as they are less influenced by muscular strength (Malina and Bouchard, 1991; Beunen and Malina, 1996; Sherar et al., 2007). The sample was in the pubertal age group, and the differences in muscular strength between the sexes decrease with increasing age and female sexual maturity, so it is assumed that in this growth phase, the performance recording is as distinct as possible from strength recording (De Ste Croix et al., 2003; Faigembaum et al., 1996).

Moreover, the vertical jump test was chosen. This test is used to measure the lower limb muscle power and explosiveness of athletes. It is a relevant test in various sports disciplines such as basketball, volleyball, soccer, and track and field. The most common vertical jump test involves jumping from a standing position and measuring the distance between the starting point and the highest point reached during the jump, using the so-called Reach parameters (Bosco et al., 1983; Sayers et al., 1999; Markovic et al., 2004).

Among vertical jump tests, the most used is the Sargent variant, used to evaluate the lower limb explosiveness and muscle power of athletes and as an indicator of their ability to generate force quickly. It is also used as an assessment tool for sports performance and as a means of monitoring athletes' progress over time (Young and James, 2009; Bailey and Maillardet, 2010; Trecroci et al., 2015). Furthermore, this test has often been used to evaluate explosive capabilities in adolescent athletes. In his 2018 review, Schwesig evaluated gender and age differences in vertical jump performance using this test. There are studies that specifically suggest that females are less influenced by strength in vertical jump performance during puberty. (Moran et al., 2006; Sayers et al., 1999).

In conclusion, we can say that the vertical jump test is an important indicator of lower limb muscle power and athlete explosiveness. In pubescent females, this value is less influenced by muscle strength, allowing for greater observation and study of kinetics (Lloyd et al., 2014). Finding differences in the same test for the same athlete based on teaching methods (cause vs. effect) may indicate an actual need to differentiate internal focus on a specific muscle area.

METHODS

We chose to use a test for evaluating vertical jump, the Sargent Jump Test (SJT), also known as the Vertical Jump Test or Standing Vertical Jump Test (Sargent, 1921). SJT is used to evaluate the power and explosive strength of the lower limbs expressed in a jumping task. The test was performed by each athlete jumping vertically in front of a graded wall, without a running start, and touching the highest possible point on the wall with their fingertips. The measure of the jump was taken as the distance between the lowest fingertip touch and the floor. The result of the test is expressed in centimetres and represents the maximum height reached by the vertical jump. The formula used to calculate the test score is: Sargent Jump Test = Average of jumps - Reach. The average of jumps represents the average of five consecutive but separate jumps allowing for adequate repositioning performed by the subject. The reach represents the distance between the floor and the individual's fingertips with their arm fully extended in an upright position. (Ibidem)

Each athlete-subject performed SJT for three different sessions. Each session was distinguished by the type of executive teaching proposed. Each session was preceded by a heart rate check that should not have been more than 5 bpm compared to the baseline. All participants had never undergone this test before. The test sessions, which we will call S1-S2-S3, were randomized. To avoid executive learning, the sessions were carried out at the necessary time interval to allow the athlete-subject the necessary recovery and learning of the different executive request. No athlete had different teachings, and no motivation was provided during execution. All subjects performed tests S1, S2, and S3 on linoleum flooring, with appropriate footwear, and at the same time of day, in the luteal phase. Some studies have shown a positive correlation between the follicular phase and muscle performance (Lebrun et al., 1995; Sung et al., 2014). All executive teachings were given before the start of the test sessions. The present experimenters were always two.

In the S1 jumping session, the subject was asked to "*jump as high as possible, go as high as possible, reach the highest point of the wall with their hands.*" S1 can, therefore, be attributed to the test session in which the teaching was for effects, the athlete's attention was placed on the effect of the thrust, going up, and not on the cause. This instruction was given to focus attention on the effect of the pushes, i.e., jumping upwards, not on the cause, the push downwards.

In the S2 jumping session, the subject was asked to "*push down the floor, push the floor as hard as possible, imagine sinking it.*" S2 can, therefore, be attributed to the test session in which the teaching was for causes, the athlete's attention was placed on the cause of the jump, i.e., the push of the lower limbs downwards. This indication was used to focus attention on the real cause of the jump, which is the downward push of the lower limbs.

In the S3 jumping session, the subject was asked to "*remember the correct jumping technique, concentrate on the jumping technique, jump as if they were performing a technical exercise.*" S3 can, therefore, be attributed to the test session in which the teaching was technical, the athlete's attention was focused on the vertical jump technique.

Sample

All the tested subjects were Caucasian females with ages ranging from 13 to 17 years.

All subjects were selected from a sample of trained female athletes with the same experience in vertical jump technique. Furthermore, they were selected based on their sports training ability, excluding those who did not show the ability to understand the commands in pre-test tasks, ensuring the ability to understand and apply the requests made by the experimenters.

All subjects underwent S1, S2, and S3 tests after checking their baseline heart rate and randomizing the test sessions.

A total of 70 subjects with a mean age of 15.2 years were tested. All athletes were healthy, and none were in functional recovery. All athletes were found to be symmetric in lower limb morphology control tests.

Data analysis

The S1 test (taught for EFFECTS) shows a normal distribution of the results (in cm) of the high jump measurement. The measurement of the jump obtained in the three tests was compared, verifying both the mean and the distribution of any observed variations. The results were also checked through a significance test of the data using logistic regression analysis.

Figure 1. Test S1. Distribution by results.

RESULTS

The mean measurement of the jumps obtained in the S1 test is 38.1 cm. In the S2 (taught for CAUSES) and S3 (taught for TECHNICAL) tests, an improvement in the mean of the jump measurement is observed:

- S2 test (taught for CAUSES): mean jump measurement = 39.0 cm, an average increase of +0.9 cm (+2.6%) compared to the mean measurement recorded in the S1 test.
- S3 test (taught for TECHNICAL): mean jump measurement = 38.5 cm, an average increase of +0.4 cm (+1.1%) compared to the mean measurement recorded in the S1 test.

The most interesting results come from reading the observation of the distribution of the improvements obtained within our reference sample. For each athlete, the variation (improvement or deterioration) of the jump measurement in the S2 and S3 tests was calculated compared to what was recorded with the S1 test.

In the jumps performed in the S2 test (taught for CAUSES), it is observed that:

- No athlete showed a deterioration in the jump measurement reached.
- 23.2% of the athletes did not improve their jump measurement.

- 62.3% of the athletes improved their jump measurement by 1 cm, equivalent to a +2.6% increase compared to the results obtained in the S1 test.
- 14.5% of the athletes improved their jump measurement by 2 cm or more, equivalent to a +6.4% increase compared to the results obtained in the S1 test.

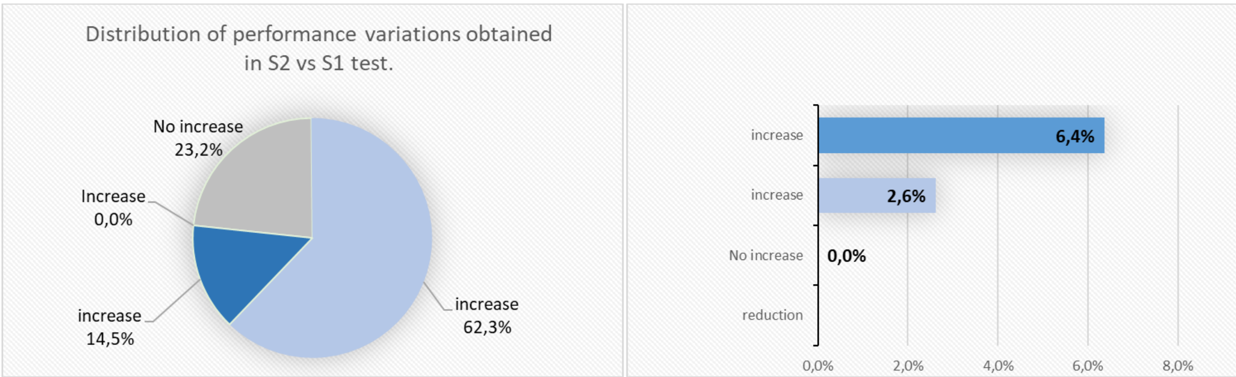

Figure 2. Distribution of performance variations obtained in S2 vs. S1 test.

In the jumps performed in the S3 test (taught for TECHNICAL), it is observed that:

- 17.4% of the athletes deteriorated their jump measurement by 1.1 cm, equivalent to a -2.8% decrease compared to the results obtained in the S1 test.
- 47.8% of the athletes did not improve their jump measurement.
- 18.8% of the athletes improved their jump measurement by 1 cm, equivalent to a +2.6% increase compared to the results obtained in the S1 test.
- 15.9% of the athletes improved their jump measurement by 2 cm or more, equivalent to a +7.4% increase compared to the results obtained in the S1 test.

The significance of the variation in jump height measured in Tests S2 and S3 compared to Test S1 was also verified through a logistic regression analysis, which showed a moderate significance of .06.

Figure 3. Distribution of performance variations obtained in S2 vs. S1 test.

CONCLUSION

In this study (Lee, 2017), several bibliographic sources were used to support the conclusions. Specifically, the work of Wulf (2013) on the effects of attentional focus on motor learning was considered, as well as the systematic review by Schoenfeld and Contreras (2016) on the effect of attentional focus on muscle strength and hypertrophy. The results of this study indeed showed that teaching based on athletes' attentional focus on their own body is an important performance variable. In fact the technical teaching of correct execution of the kinetic gesture (Technical Teaching, test S3) led to visible improvements in 34.7% of the sample, a deterioration in performance in 17.4% of the athletes, and no difference in results in almost half of the cases (47.8%).

The motor teaching based on the description of non-visible muscle contractions that initiate the visible movement (Effect-Movement) and that are the cause (Cause-Based Teaching, test S2) led to visible improvements in 77.8% of the observed sample, and in no case was a deterioration in performance observed.

It seems that the Cause-Based Teaching is more immediately understandable and actionable by athletes, leading to improvements in about 3 out of 4 athletes (77.8% showed an improvement in performance). Moreover, this tool does not have any contraindications or create complications in the motor mechanics that could translate into a deterioration in performance. In fact, in no case was a deterioration in performance observed.

Cause-Based Teaching seems to be an excellent tool for increasing performance, of simple application and very effective, allowing for immediate improvement.

Another interesting consideration that emerges from this study is the need to personalize teaching and training approaches to adapt to the specific needs of athletes. As highlighted by the results, there are athletes who respond better to a teaching approach based on correct execution of the kinetic gesture, while others benefit more from teaching focused on the cause of muscle contractions.

This means that coaches and teachers must carefully evaluate the individual needs of athletes and adapt their teaching approach accordingly. This customization can be facilitated using tools such as movement execution technique evaluation and evaluation of athletes' attentional focus during learning.

Furthermore, this study emphasizes the importance of ongoing scientific research in the field of motor learning to improve athletes' performance and develop new teaching and training approaches. Analysis of research results can help coaches and teachers better understand how athletes learn and how their teaching and training approaches can be improved.

An interesting suggestion for future research could be to further investigate the possible differences in motor learning between athletes, particularly young athletes, in relation to the use of different teaching approaches.

In particular, it would be interesting to evaluate the effectiveness of an approach based solely on technical teaching compared to an approach based on both technical teaching and the focus on the cause of muscle contractions in training young female athletes.

A possible method to test such differences could be a two-group experimental design, where one group of athletes would be trained using only a technical teaching model, while the other group would be trained using both technical teaching and teaching based on the focus on the cause of muscle contractions.

Moreover, it would be interesting to monitor the long-term effects of training, for example through the analysis of data on the athletes' performance in official competitions.

This research could provide valuable information for coaches and teachers on the most effective teaching methods for young athletes, which could be used to develop personalized and targeted training programs.

AUTHOR CONTRIBUTIONS

A. Fogliata: Author of the methodology and creator of the paradigm, coordinator of the field data collection, wrote the article except for the part related to the statistical analysis and results. R. Borghini: Author who conducted the statistical analyses and wrote the statistical results. Shared the observations for the drafting of the conclusions. A. Ambretti: Author of methodology and conclusion she is scientific coordinator of work.

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DISCLOSURE STATEMENT

No potential conflict of interest was reported by the authors.

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