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Original Article

Cognitive and dynamic ecological approach compared for improving countermovement jumping

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Abstract
Problem statement: Two motor learning approaches are used, in various ways, in the field of physical activity and sports training both for the promotion of psychophysical health and for the improvement of sports performance: cognitive and ecological-dynamic. Coaches and teachers of physical and sports activities prefer to use orders and commands that have behaviorism and cognitive theory as their theoretical basis and, therefore, there is a wealth of evidence demonstrating the effectiveness of the dynamic ecological approach. The aim of the study was to demonstrate the differences in efficacy between the prescriptive method and the heuristic method in improving vertical jump with countermovement. Method: A sample of 50 subjects, recruited for territorial convenience in the municipality of Fisciano, was divided into 2 groups. The experimental group (HEUR; N=25) followed a training protocol based on the heuristic learning method. The control group (CON; N=25) followed a protocol characterized by the prescriptive teaching method. The duration of the protocols was 8 weeks with a frequency of 3 one-hour training sessions per week. CMJ jump height data were acquired with Optojump instrumentation. The test was applied 2 days before and 2 days after the end of the training period. Dependent sample t-tests and independent sample t-tests were used to analyze pre-post differences for individual groups and differences between groups, respectively. The alpha level was set at 0.05. Results: Statistically significant improvements in jump height were shown for both groups ($p<0.05$). The protocol applied to the HEUR group was more effective ($p<0.05$). These results would demonstrate that heuristic methods, which do not provide exercises prescribed in the form of a command, stimulate the student to solve the various problems that arise.
Conclusion: The data from this study confirm the effectiveness of both approaches. Having demonstrated a greater effectiveness of the protocol based on the dynamic ecological approach provides new certainty and tools for wellness and training practitioners to use in their training programmers.
Keywords: Motor learning, Fundamental movement skills, Physical activities, Sport training, Circle Time in motor learning

Introduction

Motor learning is the set of processes that bring about a lasting or permanent change in an individual's behavioural potential (Magil, 2011; Schmidt and Wrisberg, 2000) and is expressed in the level of an individual's ability to express a motor or sports performance as a functionally appropriate response in certain contexts.
In the field of motor and sport, learning aims, through the training process, at improving the bio-motor and coordination characteristics, skills, and competences of individuals. These objectives are pursued through the definition of methodologies and tools that, together with other organizational aspects, are defined and applied in compliance with specific pre-established phases based on the individual characteristics of the subject. Two motor learning approaches are used, in various ways, in the field of physical activity and sports training for both the promotion of psychophysical health and the enhancement of performance: cognitive and ecological-dynamic (D'Isanto et al., 2022; Raiola, 2014).

The cognitive approach aims to achieve this change through the consolidation of motor programmes (Keele & Summers, 1976) with the method of prescriptive teaching following a reproductive learning style: the teacher, coach or athletic trainer prescribes drills to the student in order to stabilize and refine motor programmes (Mosston & Ashworth,2008, Goldberger et al., 2012). The dynamic ecological approach, on the other hand, is characterised by the continuous interaction and adaptation of appropriate behaviour to the environmental context (Gibson, 1979) and is not limited to internal coordination aspects (Kelso et al. 1990). The didactic method according to this approach is based on heuristic learning, which is characterised by a productive learning style, in which the learner, through discovery, reworking and creation, plays an active role, generating open, original and creative ways of responding to motor proposals (D'Isanto et al., 2022; Raiola & di Tore 2017).
In summary, the cognitive approach considers human movement from a behaviorist/cognitive interpretative perspective, while the ecological-dynamic approach is a modality that investigates the subject from a phenomenological perspective (Raiola, 2013).

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Degrees in Sport and Exercise Sciences, which aim to train the professional figure of the kinesiologist, should not limit themselves to training physical education teachers, but offer curricula aimed at training various profiles (D'Elia, 2019) that have an adequate level of knowledge to better manage the training of their clients and athletes. Kinesiologists, therefore, having the dual professional outlet of physical education and motor education teacher in primary and secondary schools (D'Elia, 2020), and instructor/coach in motor and sport (Raiola, 2019), must have a clear understanding of the methods of proposing teaching/training programmes (D'Elia, 2019).

In the context of physical and sporting activities, prescriptive exercises are traditionally used which have the cognitive approach as their theoretical basis (Altavilla et al., 2022). Coaches, trainers, and teachers carry out physical and sporting activities through simulations, orders, commands that have the theory of behaviorism and cognitive theory as their theoretical basis (Raiola & Tafuri, 2015).

There is little evidence that demonstrates the use by teachers and coaches of heuristic methods in the field of physical, motor and sports activities. Several studies have shown that learning methods and environments capable of stimulating the perceptual processes typical of a performance (both sports and everyday life) favor the development of adaptive behavioral responses in individuals with high levels of transference (Smith & Bedwell, 2021; Pinder et al., 2011). Therefore, to improve motor and technical skills, even the use of methods that refer to the ecological approach could give positive results.

Jumping represents an example of a fundamental movement skill (Logan et al., 2016) and, as such, is a building block of more complex movements (Basman, 2019; Seefeldt, 1980; Clark & Metcalfe, 2002) that occur as natural behavioral response of the individual to different environmental demands. Its development requires an adequate level of bio-motor, coordinative and adaptive skills, therefore, both approaches for its training could be useful. The counter movement jump (CMJ) with free arm swing, in particular, uses a combined eccentric/concentric muscle action defined as the stretch-shorten cycle (SSC) to which is added the energy generated by the arm swing, which is transferred to the rest of the body, causing the take-off speed to increase (Kim et al., 2014).

Previous studies have shown that appropriate arm swings can increase both deadlift speed and jump height (Feltner et al, 2004). The positive effect of swinging the arms should be attributed to the subject's ability to correctly exploit the kinetic energy produced by the muscles and transmitted through the articular joints as an adaptive response to the context. Protocols that only provide for the improvement of the mechanical aspects would not guarantee the improvement of jumping performance if they were not supported by protocols that solicit responses that are functionally appropriate to the various contexts (D'Elia et al., 2020).

Although numerous studies confirm the effectiveness of heuristic methods in developing adaptive responses, there are no studies demonstrating the use of such methods in improving complex gestures, such as the jump squat with arm swing. The aim of this study, therefore, is to evaluate the effectiveness of two different training protocols, based on the cognitive and dynamic ecological approach, in improving the CMJ squat gesture with free arms and to establish if there are differences between the two.

Material & Methods

Participants

The sample consisted of subjects (N=50; mean age 23,87±4,5 years; BMI 23,05±3,18) recruited for territorial convenience in the area of Fisciano in the province of Salerno. Of the 50 participants, 24 were male and 26 female.

The sample was randomly divided into two groups, both consisting of 12 males and 13 females: the heuristic learning group (HEUR) (N=25; mean age 23,54±4,48; BMI 23,07±3,18) participating in a training protocol based on the dynamic ecological approach and a control group (CON) (N=25; mean age 24,02±4,66; BMI 23,02±3,24) participating in a training programme based on the cognitive approach.
All participants were informed of the study objectives, procedures and risks prior to participation in the study.

Data collection

The counter movement jump (CMJ) squat test with free arms using Optojump Microgate instrumentation was used to measure reactive force. The CMJ free-arms test was used to analyse the subjects' ability to jump after countermovement of the lower limbs by minimising constraints on the upper body, and thus making maximum use of its ability to process appropriate responses to environmental demands.

The test was performed 2 days before the start of the respective training protocols and 2 days after the end of the 8-week period. The test was performed using Optojump Microgate optoelectronic instrumentation and a test area measuring 60 x 90 cm (figure 1). Three tests were performed with a 2-minute recovery between them and the average of the three tests was used.

Only the jump height in centimetres (cm) was considered.
Before the reactive force test, the weight and height of the subjects were acquired in order to ascertain their anthropometric characteristics. These measurements were taken in the morning, on an empty stomach.

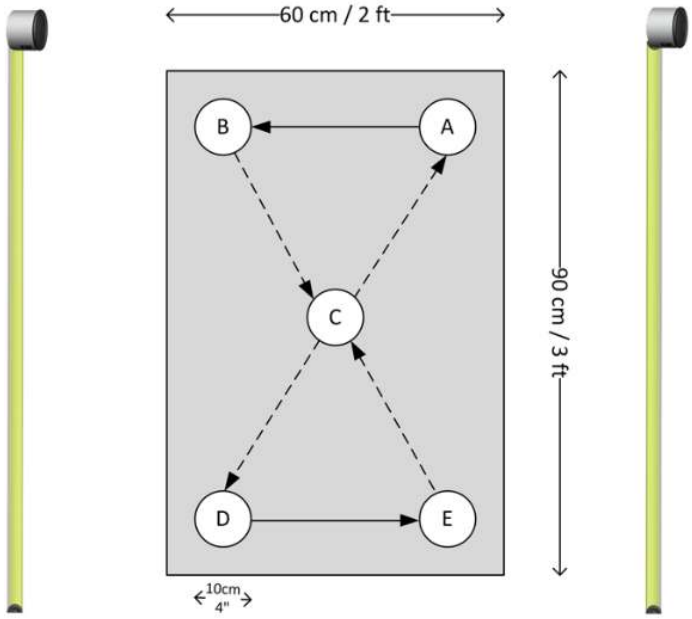

Figure 1 Test area

Protocols

The training protocols lasted a total of 8 weeks, characterised by micro-cycles of 3 weekly training sessions of approximately one hour each

Protocol based on the dynamic ecological approach

The structured protocol for the HEUR group was characterised by training programmes based on heuristic learning, which aim to stimulate appropriate responses in the trainees according to a productive style, with the coach assuming the role of a guide who helps his or her trainees to find problems and solutions to these problems. The day before the start of the HEUR protocol, the Circle Time tool was used to comment on the outcome of the test results and in which the general objectives were set and the overall planning for achieving them was defined. This first meeting lasted 60 minutes in which all pupils, arranged in a circle and guided by the coach, expressed their thoughts and hypothesised solutions. Each intervention lasted 2 minutes per pupil. The coach noted down all observations and defined a general programme that was then approved by the pupils.

Each session was characterised by the random division of the HEUR group into 5 subgroups of 5 subjects each. The protocol comprised 5 phases:

1. Initial phase: use of Circle Time in which the trainees, with the coach, arranged themselves in a circle so that each one could have everyone's attention. The coach took a leading role in finding the most appropriate solutions for the benefit of the group.
2. Warm up: exercises for general activation of the body
3. Central phase: characterised by structured training programmes based on the general objectives and programming and the modifications defined during the pre-workout Circle Time phase.
4. Defatigue phase: return to basal conditions.
5. Final phase: Circle Time.

Table 1 shows and describes the five characteristic steps of the HEUR protocol.

Table 1 HEUR group training protocol based on the Dynamic Ecological Approach

Phases	Method	Description	Duration
Initial phase	Circle time	The athletes and the coach came together in a circle and identified problems and goals to be achieved. Solutions were identified to consolidate or improve on what had been done the day before or new strategies were proposed, but always respecting the overall planning.	10’
Warm up	Joint mobility, moderate intensity work	Activation of the cardiovascular and neuromuscular systems and lubrication of joints	10’
Central phases	Strength expression exercises (different depending on the period)	Methodologies and tools with specific intensities for improving the various expressions of strength and core stability agreed on a case-by-case basis through Circle Time and based on the general programming defined in the first meeting	50’
Cool down	De-fatigue and stretching exercises	Returning the organism to acceptable levels of equilibrium	10’
Final phase	Circle time	Short meeting to identify the criticalities and strengths of the session just concluded	5’

Protocol based on the cognitive approach

The CON group followed a training protocol based on the prescriptive teaching method. The training session was characterised by 3 phases:

1. Warm-up
2. Central phase
3. Defatigue

Table 2 shows and describes the five characteristic steps of the CON protocol.

Table 2 CON group training protocol based on the Cognitive Approach

Phase	Description		Load	duration
Initial phase	Neuromuscular and cardiovascular activation with joint mobility exercises		Da basso a moderato	10’
Central phase	Methodologies, tools and contents useful for improving strength in its expressions	1° day power clean 4x3 Drop jump 4x5 Back squat 3x10-8-6 leg extension 3x12 2° day Med ball thruster 4x6 box jump 4x5 Alternating barbell lunges 3x8(a gamba) Sitting calf machine 3x20 3° day Kettlebell swing 4x12 Alternating monopodalic leaps 4x4 (per lato) deadlift 3x10 leg curl 2x12	Moderate to high (40-85% di 1RM)	50’
Cool down	De-fatigue and stretching exercises		Low load	10’

Statistical analyses

Descriptive statistics (mean ± SD) are calculated for the different variables. The distribution of each variable is examined using the Shapiro-Wilk test. A t-test is used for dependent samples to determine the differences between the input and output data for both groups. A t -test is used for independent samples to determine whether differences exist between the effects of the two protocols. All analyses are performed using SPSS software (version 22; IBM, Armonk, NY, USA) and the alpha level for significance was set at 0.05.

Results

All subjects completed the planned 8 weeks of training. Tables 3 and 4 show, respectively, the results of the arm swing CMJ test before and after the application of the protocols of the CON group and the HEUR group. Improvements in jump height were evident in both groups: specifically, the improvement was 12% for the CON group to which a training protocol based on the prescriptive method was applied and 20% for the HEUR group to which a protocol based on the heuristic learning method was applied.

Table 3 CON Result CMJ test pre-post

					CMJ pre		CMJ post		Pre-post difference	
N=25	Age	Weight (kg)	Height (m)	BMI	Flight time (sec)	Jump Height (cm)	Flight time (sec)	Jump Height (cm)	Flight time (sec)	Jump Height (cm)
Mean	23,54	65,64	1,68	23,07	0,5	30,94	0,53	34,756	0,03 (7%)	3,82 (12%)
SD	4,48	13,58	0,08	3,18	0,06	7,51	0,05	7,82	0,06	5,59

Table 4 HEUR Result CMJ test pre-post

					CMJ pre		CMJ post		Pre-post difference	
N=25	Age	Weight (kg)	Height (m)	BMI	Flight time (sec)	Jump Height (cm)	Flight time (sec)	Jump Height (cm)	Flight time (sec)	Jump Height (cm)
Media	24,2	65,64	1,68	23,02	0,49	31,5	0,56	37,98	0,07 (14%)	6,48 (20%)
SD	4,66	13,58	0,08	3,25	0,08	7,31	0,05	6,32	0,05	3,50

The results of Student's t-tests for dependent samples, shown in Tables 5 and 6, show that the differences found between pre- and post-training were statistically significant for both groups ($p<0.05$).

Table 5 CON T student paired samples results

	Height pre	*Height post*
Means	31,496	37,98
fd	24	
Stat t	-9,2541485	
P(T<=t) two-tail	0,00229752	
T Critical two-tail	2,06389856	

Table 6 HEUR test paired sample results

	Height pre	*Height post*
Means	30,944	34,756
fd	24	
Stat t	-3,410497	
P(T<=t) two-tail	2,1844E-09	
T Critical two-tail	2,06389856	

The t-test for independent samples found a statistically significant difference ($p<0.05$) between the two groups. Table 7 shows these results.

Table 7 T-test results for independent samples between the two groups compared

	Height CON	*difference*	*Height HEUR*	*difference*
Means	3,812		6,484	
fd	48			
Stat t	-2,0255022			
P(T<=t) two-tail	0,04839525			
T Critical two-tail	2,01063476			

Discussion

The aim of the study was to demonstrate the effectiveness of the two protocols applied and the differences between the two groups tested with regard to jump height after an 8-week training period: one protocol was characterized by the prescriptive teaching method and the other by the heuristic learning method that stimulated the emergence of functionally useful behaviors.

Regarding the first objective, the data showed that the CON group had a jump improvement of 3,82±5,59 cm, while the HEUR group improved their jump height by 6,48±3,5 cm. These results are statistically significant in both groups ($p<0.05$) so the hypothesis of effectiveness of both protocols is accepted.

The data show a greater efficacy of the heuristic learning-based protocol compared to the alternative protocol. This difference is statistically significant, so the hypothesis that the two protocols are not equally effective in improving this skill is accepted.

These results can be explained by the very characteristics of the method used based on the theories of the dynamic ecological approach, according to which, since there are no exercises prescribed in the form of a command, the student is stimulated to solve the various problems that arise (Raiola, 2017). Thus, letting individuals find spontaneous solutions through discovery and self-organization can foster the emergence of personal solutions with respect to optimizing the act. The dynamic ecological approach tends to foster the relationships and interdependence of individuals with the environment in order to facilitate the emergence of specific behaviours in various contexts, both every day and sporting (Araújo and Davids, 2016; Teques et al., 2017).

The use of circle time also certainly contributed to the effectiveness of the protocol proposed to the HEUR group, as, through this tool, the social aspects of inclusion and the participants' ability to listen and express themselves are stimulated. Circle time represents a valuable tool for developing individuals' social skills, improving self-esteem and can address the needs of individuals with behavioural difficulties (Canney and Byrne, 2006; Lown, 2002)

This study has a number of limitations, including the use of convenience sampling, with the consequent impossibility of generalizing the results to the entire population, and the lack of studies regarding the improvement of this specific motor task using the methods of the dynamic ecological approach. Therefore, it may be useful to extend the study by diversifying the sample and also consider other fundamental motor skills.

Conclusions

The data of this study have provided important evidence that confirms the effectiveness of both approaches in the field of physical activity and sport in improving complex skills such as countermovement jumping. Specifically, it was demonstrated that the protocol structured according to the dynamic ecological approach through the use of the circle time tool was more effective than the traditional approach based only on the repetition of exercises according to criteria and schemes established in advance by the coach. Having demonstrated greater effectiveness of the protocol based on the dynamic ecological approach, new certainties and tools are provided to wellness and sports training operators that can be used in their training programs together with or as an alternative to protocols based on the prescriptive approach. This approach can be a further tool to diversify the training proposal and make training more fun and engaging as it stimulates spontaneous solutions for different needs. Further studies will help to implement knowledge of the topic through probabilistic sampling that focuses attention on other complex movements in order to identify the limits of effectiveness of the methods.

Conflicts of interest - If the authors have any conflicts of interest to declare.

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