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VERBAL INSTRUCTIONS IN TEACHING SPORT PERFORMANCE: A CASE STUDY

E ISTRUZIONI VERBALI NELLA DIDATTICA DELLA PERFORMANCE SPORTIVA: UN CASO DI STUDIO

Valeria Agosti
University of Bergamo, Italy
valeria.agosti@unibg.it

Abstract

In the last years, sports science has been focused on theoretical and teaching models for maximizing training results and building sport-specific performance models which include cognitive aspects of action (i.e. attention, memory). Recent studies underline that cortical motor areas are involved not only in the movement execution but also in the elaboration of words and phrases related. Moreover, it has been shown that cortical areas typically involved in production and decoding of language, linked by functional circuits with the motor and premotor areas, are directly involved in motor learning. Particularly, Broca's area contributes to observation, planning, understanding and imitation of the actions. In this direction, several studies have looked at how verbal instructions (language) can fit as a cognitive element in sport performance models where, consistent with the more recent neurophysiological knowledge, the production and understanding of language might fit into the complex coach/athlete relations. Preliminary results of a case study, pointed in this direction, will be presented.

Negli ultimi anni la scienza dello sport ha orientato il suo interesse verso lo studio di modelli teorici e didattici indirizzati a massimizzare i risultati dell'allenamento, strutturando modelli prestazionali sport-specifici che includono gli aspetti cognitivi dell'azione (come ad esempio l'attenzione, la memoria, etc.). Studi recenti hanno messo in evidenza che le aree motorie corticali sono coinvolte non solo nell'esecuzione del movimento ma anche nell'elaborazione di parole e frasi ad essa correlate. Inoltre, è stato dimostrato che le aree corticali classicamente coinvolte nella produzione e decodifica del linguaggio, collegate da circuiti funzionali con le aree motoria e premotoria, sono direttamente coinvolte nell'apprendimento motorio. In particolare, l'area di Broca contribuisce all'osservazione, pianificazione, comprensione e imitazione delle azioni. In questa direzione, diversi studi hanno indagato sull'uso delle istruzioni verbali (linguaggio) quale elemento cognitivo dei modelli prestazionali dove, in linea con le attuali conoscenze neurofisiologiche, la produzione e la comprensione del linguaggio verbale potrebbero essere un supporto nella costruzione della complessa relazioni allenatore/atleta. In questa prospettiva, verranno presentati i risultati preliminari di un caso studio.

Keywords
sport performance; cognition; language; verbal instruction
performance sportiva; cognitività; linguaggio; istruzioni verbali

Introduction

The sports and training sciences have classically understood the maximization of performance in a purely quantitative perspective, where physiological parameters complement each other with technical and tactical elements. As a result, teaching methods have evolved in this way, in a linear direction, where the teacher / coach prescribes and the student / athlete performs. In recent years, the theoretical models of training have finally turned to non-linear pedagogy and to the theory of complex systems: the result is a change of perspective aimed at looking at training as a complex pedagogical-educational process (Agosti & Madonna, 2020; Platonov et al., 2018). These theoretical models have recently evolved into educational practices giving new methodological inspiration to sports training (Chow et al., 2015; Schenk & Miltenberger, 2019), also in the reformulation of sport-specific performance models; this are the educational models, which mediate the relationship between pedagogical theory and educational practice. A new path has finally been undertaken towards understanding and assimilating the most current knowledge deriving from the world of neuroscience to lower them into sports performance. Performance models have thus been enriched with cognitive processes: perception, attention, vision, memory, representation and language (Roi & Bianchedi, 2008) are now fully considered elements of sports performance and, as such, must be trained. The motor function then becomes the result of the variable organization of the relationships between the elements of the system, and takes place with respect to a specific purpose represented by the learning of the specific sport gesture.

In this article, attention will be paid to language, in its verbal expression, to search for the elements to enhance its role as a cognitive element of sports performance and to analyze, through a preliminary study of Motion Analysis, its educational potential.

1. Language, verbal instructions and sport performance

An extraordinary system allowing individuals to communicate an infinite combination of ideas, using a highly structured flow of sounds. With the simple act of emitting a series of noises with our mouth, we are able to give rise to new combinations of ideas in our minds. This ability, language, appears so natural to us that we even manage to forget how miraculous it is (Pinker, 2003).

In linguistics, the scientific research activity of the last forty years has shown that all languages, verbal and non-verbal, are based on particularly similar general principles. They are an ability developing spontaneously since childhood; from a spontaneous process, it then becomes a cultural adaptation, widespread throughout our species and which finds its place in a series of highly complex areas and nervous circuits (Kandel et al., 2021).

Verbal language gives the human brain an extraordinary tool to organize knowledge of the world and to represent this knowledge through complex and abstract concepts, which no animal species shares, to process the experiences with the environment, guide decision-making processes, and organize behavior. Even today there is no agreement on the origin of verbal language. One theoretical strand hypothesizes that verbal language represents the most evolved form of animal communication, while the other argues that verbal language is a discontinuous element in the evolution and specific to humans.

International literature is dedicating increasing interest to verbal language, in particular to the role that verbal instructions (VI), a cognitive expression of verbal language, have as a perceptual mediator in the organization of motor and sports performance. In fact, it has been shown that the cortical areas classically involved in the production and decoding of language, connected by functional circuits with the motor and premotor areas, are directly involved in motor learning. In particular, the Broca's area contributes to the observation, planning, understanding and imitation of actions (Zhang et al., 2018). Furthermore, recent studies have highlighted how cortical motor areas are also involved not only in the execution of the movement but also in the processing of words and phrases related to the execution, so as to influence its manifestation (Hauk et al., 2008). However, many questions still remain unsolved, such as how, if and which specific functions of verbal language (e.g., those relating to syntax) have common developmental roots with the perception and motor functions supported by Broca's area, and in which measure their neuronal correlates overlap (Grodzinsky, 2000).

Such knowledge, although still evolving, subverts the idea of *motor command* in favor of *verbal instruction*: talking to the athlete means orienting him towards the choice of the significant elements of the performance to build his motor experience originating from practice and that it is at the same time theory for future actions (Agosti, 2018). A motor experience that is a perceptive experience, because it is a sensory element with an acoustic and motor meaning, and which acquires a content because it is body-mediated.

The main studies investigating the role of the VI in the organization of motor function have to date focused on evaluating above all a single motor action, the landing from the jump, meaning it exclusively in its final manifestation. The reasons for this choice lie in the fact that a wrong biomechanical organization in the impact on the ground can result in a predisposing component of knee injury, even in elite athletes (Hewett et al., 1996; Prapavessis & McNair, 1999; Ford et al., 2003; McNair et al., 2000; Mizner et al., 2008). Milner et al. (2012), using a very complex and technologically advanced biomechanical analysis system, verified the kinetics and kinematics varations in athletes undergoing three different VIs for landing from a counter movement jump: landing (a) with the knees above the toes, (b) with equal weight distribution on both feet, and (c) as softly as possible. The final results showed that VIs (b) and (c) changed the performance in a positive way with respect to the biomechanical organization by increasing the joint angles of the knee for impact cushioning, reducing Ground Reaction Force and improving symmetry; on the other hand, the VI (a) did not significantly change the performance.

These results, although interesting, give us relevant information on the potential of VI in motor organization but provide us with few suggestions regarding the transference in the sport-specific gesture and how, not only to what extent, this mediated VI neuromotor organization could modify the final execution in its biomechanical *form*.

In this direction, the aim of this case study is to investigate, through a quantitative analysis of the kinematic parameters, if and to what extent a VI created by recalling intracorporeal perceptual / cognitive elements, can be useful to modify the motor performance of the athlete and therefore constitute a meaningful and shared language between coach and performer, such as to activate that system of neural interaction that leads the athlete towards meaningful learning. The study was approved by the local Ethic Committee and signed informed consent was obtained.

2. Case description

This case study refers to a fencing athlete (20yrs; mass, 73.25 kg; height, 1.70 m) with a history of anterior knee pain (right), not attributable to any pathology, which comes out in the fencing lunge, when the right lower limb is used as a support (when the foot lands on the ground). In the same athlete a high risk of injury to the right knee (valgus posture) was preliminarily assessed, comparing it to the left knee, through the Landing Error Scoring System (LESS), a validated video analysis tool, used to evaluate the kinematic organization of landing from a jump (Padua et al., 2011) and identifying biomechanical causes of injury to the lower limb.

Instruments

A 6-camera, 3-dimensional optical motion capture system (Qualisys, SE), with a sample rate of 120 Hz, were used to collect kinematic data. Sixteen reflective markers (12-mm diameter) were attached over the patient's boney landmarks, according to a modified Davis protocol (Agosti et al., 2016; Sorrentino et al., 2016; Rucco et al., 2017). Data were collected at the Motion Analysis Laboratory of the University of Naples Parthenope. The subject was barefoot (to limit the effect of different shoes or progressive wear on the same shoes). He was given two warm-up trials to get accustomed to the testing. Kinematic data were collected for both lower extremities; however, only the results for the right knee and ankle on the transversal plan are presented. The mean of six trial were used for analysis using a Matlab custom made script.

Procedure

In order to better identify the VI's effect on biomechanical motor performance, data were collected in three times: t0, (no VI); t1, (with technical VI); t2, (with kinesthetic VI). Two different motor task were used: the first one, not sport-specific, a jump from a 30cm high step (jump), to replicate the LESS; the second one, sport-specific, consisting in a fencing lunge (lunge). In this double biomechanical evaluation, the conditions of the jump at t0 and t1 provided a guide not only to grasp the elements to be corrected in the lunge, that is the valgus attitude of the knee of the supporting leg, but also to identify the significant elements, intracorporeal, specific for the athlete, to build the VI used at t2 for both motor tasks: "on landing, be prepared to feel the same pressure under your feet and to distribute the weight by cushioning with the pelvis". The VI called kinesthetic was built during the t1 tests for both performances, raising a dialogue with the athlete and, at the same time, finding that subjective, intracorporeal elements significant for him as an attentional trace. In Fig.1 the timeline of the study.

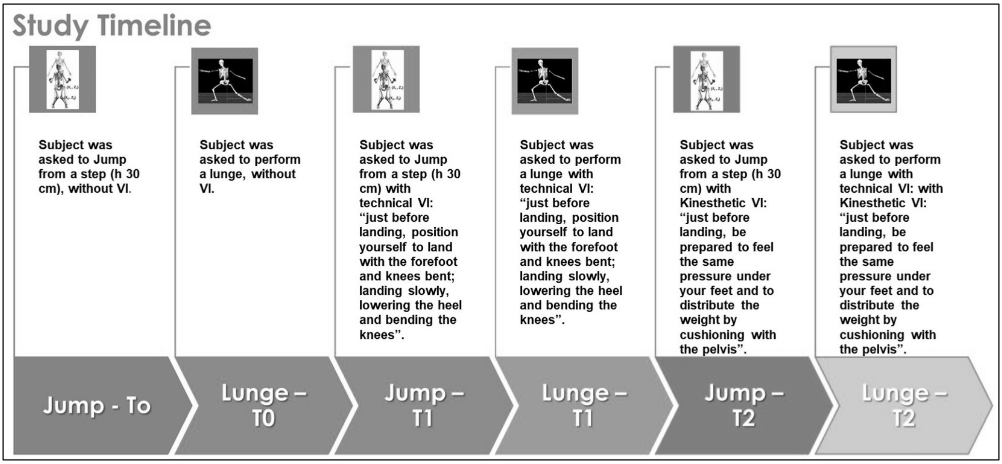

Fig.1 – The timeline details the methodological steps of the study in terms of timing and motor tasks, also referred to the detailed VIs.

Motion Analysis

For the biomechanical analysis, two events were created for both performances: the first one, at the initial contact of the lower limb to the ground (impact); the second one, at the peak of flexion before the rising phase (cushioning). From these two events of the jump and lunge, the internal / external rotation ranges (valgus - transverse plane) were obtained using a Matlab custom made script (Rucco et al., 2020).

Results and Discussion

Right knee and hip excursion, referred only to jump internal-external rotation (valgus) are displayed graphically in the Fig. 2. Instead, descriptive statistics for both performances, including means and standard deviations, from the knee and hip kinematic were examined ad displayed in Table 1.

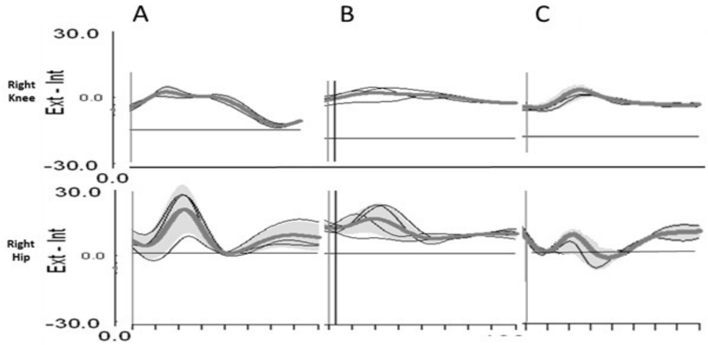

Fig. 2 – Graphical representation of right knee and hip external/internal angle referred to jump task: A): no VI; B): technical VI; c): kinesthetic VI.

	Jump no VI (t0)	Jump t-VI (t1)	Jump k-VI (t2)	Lunge no VI (t0)	Lunge t-VI (t1)	Lunge k-VI (t2)
Right knee valgus degree (mean±SD)	3,24±0,48	3,02±1,23	1,67±0,02	4,53±0,52	3,74±0,52	3,02±0,11
Right hip Valgus degree (mean±SD)	29,33±4,33	15,24±4,48	13,44±1,06	11,67±2,42	10,54±0,48	9,48±0,18

Table 1 - Kinematic data are mean±SD from 6 trials. Value express the mean degree value between two events (impact and cushioning) on transverse plan; t_0: baseline evaluation; t_1: motor task with technical VI; t_1: motor task with kinesthetic VI; SD: Standard Deviation.

Concerning kinematic curves, the interesting data, however, does not lie in the peaks of the curve but in the shape of the curve. Fig. 2 shows that the trends of curves A) and C) are more harmonic forms. In detail, curve A), albeit with very high valgus peaks, with out-of-normal excursions from joint alignment, still follows a softer trend; what also happens in curve C), albeit with more suitable excursions to joint alignment, as if to demonstrate harmonious joint cushioning. On the other hand, curve B) shows very limited excursions and a curve with a flatter course, as if to demonstrate a limitation to normal joint stiffness. Concerning the valgus data, at t1 and t2, for both types of VIs, a decrease in the angle in valgus is evident compared to t0; this decrease is evident for both the knee and the hip, and for both performances. The most interesting data, however, is in SD, which at t2 is lower than at t0, but also at t1. This shows a decrease in the variability between the tests.

However, as a result of kinesthetic VI, athlete refers a painless lunge performance.

Conclusions

With the aim to investigate the effect of different modalities of VIs on movement organization, to our knowledge this is the first study which quantifies joint lower limb kinematic, by means a Motion Analysis system, in three times and in two different motor tasks.

Overall, our results highlighted that, according to the previous study, there were differences in biomechanical outcomes between landing techniques mediated by different VI's. We have shown that different VI's results in different subject motor organization are associated with two landing techniques. Both techniques have been effective in changing the basal motor organization (no VI) by modifying landing biomechanics: VI's with a technical task lead to a stiffening of the movement, invalidating the cushioning during landing; conversely, VI's with kinesthetic task lead to a more harmonic lower limb organization, which result in a better cushioning. kinesthetic VIs are built on subjective perceptions and are effective in transferring from a generic motor task (jump) to a sport-specific motor task (lunge); intervention programs should take into account the interaction between VIs landing technique and lower limbs biomechanics.

From these preliminary data, however, it emerged that a VI built on a non-specific performance and, as required by recent training theories, that link the environment, the task and the athlete, would allow the latter to build a motor experience to find the significant intracorporeal elements useful for an autonomous and effective reorganization of the specific sport performance.

The study have several limitation. It is a case control and a preliminary study, so the results can only be a guidance for further studies having a statistically significant sample. Furthermore, the study investigates only the data from the painful right lower limb, without comparison with the left lower limb kinematics. This is because the athlete plays a sport that requires an asymmetrical use of the body, like fencing. Further studies and insights will be necessary to validate what has been observed in this preliminary phase, also analyzing both kinematics, in all the three space planes, and kinetics data.

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