Acquisition of the Long Jump Skill, Using Different Learning Techniques

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This study examined the contribution of instructional self-talk and observational learning on the development of long jump technique. Sixty-nine beginner athletes were randomly assigned to four groups: ‘self-talk’, ‘video’, ‘self-talk + video’ and control group. All groups performed 24 practice sessions, consisting of a cognitive intervention program in the form of either instructional self-talk or observational learning, or a combination of both, and the practice of specific drills. A significantly higher performance improvement was recorded for the self-talk group in post test, whereas when kinematic variables of the motor skill (center of mass displacement) were assessed, “observational learning” proved to be more effective. The findings of the current study suggest that young, beginner athletes, participating in complicated tasks, may benefit from cognitive intervention techniques, through enhanced attentional focus on the most critical elements of the motor skill.

The acquisition of a motor skill, beside the practice of specific drills (physical practice), usually applied by coaches, may be reinforced by supplementary learning techniques such as ‘self-talk’ and ‘observational learning’, which enhance selective attention and memory and contribute to a more accurate performance reproduction as well (Bandura, 1977; Hardy, Gammage, & Hall, 2001; Janelle, Champenoy, Coombes, & Mousseau, 2003; Zinsser, Bunker, & Williams, 2001). Depending on the nature of the skill to be learned, different coding mechanisms should be used by the learner to interpret the different sources of information needed to perform a skill (Magill, 1993). A demonstration may enhance visual coding and thus qualitative performance (technique elements, kinematics), whereas verbal explanations may induce verbal coding and thus enhance quantitative or sequential task recall (McCullagh, Stiehl, & Weiss, 1990).

Long jump is a closed, discrete, self-pacing motor skill (Woods, 1998), requiring coordination, accuracy and power. It consists of four manageable segments (approach run, takeoff, flight and landing) performed successively. The ability to develop a high sprinting speed during the approach run (Hay, 1993) as well as optimal takeoff conditions (Linthorne, Guzman, & Bridgett, 2005) are the most important factors determining long jump performance.

Cognitive theories of learning generally argue that performers rely mainly on visual and verbal cues during the early stages of learning (Fitts & Posner, 1967). Different coding mechanisms (visual coding through observational learning and verbal coding through self-talk) may operate, underlining the critical aspects of task requirements to ensure maximal motor performance reproduction (McCullagh et al., 1990; Wiese-Bjornstal & Weiss, 1992).

According to literature, self-talk consists of verbalizations or statements addressed to the self, interprets elements associated with the content of statements employed, and serves at least two functions: cognitive/instructional and motivational for the athlete (Hardy, 2006). The cognitive/instructional function refers to learning and performing sport skills, and includes statements related to attentional focus, technique information and tactical choices. The motivational function refers to self-encouragement, self-confidence, mental readiness, arousal regulation, positive moods and coping (Hardy et al., 2001; Zervas, Stavrou, & Psychountaki, 2007; Zinsser et al., 2001). However, not all types of self-talk are equally effective for all tasks. It has been suggested that motivational self-talk is better suited to strength and endurance tasks, whereas instructional self-talk is more suitable for movements that involve skill, timing, coordination and precision (Theodorakis, Weinberg, Natsis, Douma, & Kazakas, 2000).

Experimental studies support the usefulness of self-talk as a learning tool (Hatzigeorgiadis, Zourbanos, Galanis, & Theodorakis, 2011). Instructional self-talk has been proved effective in acquiring fundamental basketball skills for young, novice players (Perkos, Theodorakis, & Chroni, 2002), in improving skating performance for young figure skaters (Ming & Martin,
Concerning the combination of visual and verbal cues, Landin (1994) suggested that in addition to the visual input provided by a model, verbal cueing may facilitate the performance of the task by verbally indicating important form characteristics. The additional reinforcement provided by verbal cues may enable a more elaborated coding of the observed skill thanks to the enhancement of both the attention and the retention stages of information processing (Bandura, 1977).

Taking into consideration that the acquisition of a novel task, requiring coordination and accuracy, depends heavily on concentration (Hatzigeorgiadis et al., 2011), as well as that young, beginner athletes are characterized by limited attentional and retentional subprocesses (St-Marie, Clark, & Latimer, 2002), we designed a long jump training program, enriched by two cognitive techniques not examined together before, which aimed to enhance attention to the task. Thus, the purpose of this study was to examine the influence of an intervention training program, consisting of specific long jump drills and the use of either instructional self-talk or observational learning (through video observation) or a combination of both, in young beginner athletes, on kinematic variables and on long jump performance. One line of inquiry with limited focus to date is the examination of movement kinematics. Performance improvement resulting from cognitive interventions might be associated with changes in either movement patterns or other related parameters, extending knowledge on how self-talk and observational learning may influence skill execution.

According to the learning principles (Schmidt & Bjork, 1992) individuals are more likely to present greater improvement at the early stages of learning than at the later stages. So, it was hypothesized that all four conditions would lead to an improved skill performance in the posttest compared with the pretest. The combined application of both verbal and visual stimuli would be expected to facilitate attention to critical elements of the skill, and would enhance retention of the observed action through an elaborated coding and consequently the formation of a more information-rich symbolic representation from which motor actions could accurately be reproduced. As such, practice mode using either instructional self-talk or observational learning or the combination of both was expected to be more effective in the acquisition of long jump compared with the control condition.

**Method**

**Participants**

The participants of the current study were initially eighty track and field athletes, who were considered to be “first-time participants in organized practices”—beginners. They were selected through a ‘talent’ development process, conducted by the National System of Athletic Development. During the intervention program, eleven participants withdrew from the study due to injury, inadequate attendance or adverse experiences. At the
end, sixty-nine (26 M, 43 F) young (M age = 10.3 years, SD = 0.8) track and field athletes completed all study procedures.

Variables

Practice mode was the independent variable with four levels: a) only physical practice (practice of specific long jump drills; control condition), b) self-talk + physical practice (ST), c) observational learning (through video observation) + physical practice (V), d) self-talk + observational learning + physical practice (ST+V). The dependent variable was the development of the long jump technique, determined by performance scores (m) and kinematic parameters of long jump. More specifically, the kinematic parameters assessed were the horizontal velocity of the athlete’s center of mass at the instant of touchdown on the board (Vxtd; m/sec), the vertical velocity at the instant of takeoff (Vyto; m/sec), the speed at takeoff (Vr; m/sec) and the height of the center of mass (CM) at four different points: during the touchdown at the last-but-one stride (hcmtdls; m), and touchdown (hcmtd; m), maximum knee flexion (hcmmxf; m) and takeoff (hcmto; m) during the contact phase.

Procedure

The study received Ethical Approval by the General Secretariat of Sport ethics committee, while informed consent forms were obtained from the participants’ parents.

Two skill evaluation sessions were conducted, including standardized pre- and posttests. After the pretest, participants were randomly assigned to four groups: ‘self-talk’ (ST), ‘video’ (V), ‘self-talk + video’ (ST+V), control group. All participants performed 24 practice sessions (3 sessions/ week), over an 8-week period, consisting of an intervention program in the form of either instructional self-talk or observational learning (through video observation), or a combination of both (ST+V), and the practice of specific long jump drills. All groups had the same coach but different practice timetables so that each group was not aware of the learning modality of the other groups.

Each training session lasted 90 min and was consisting of a 15 min intervention program (self-talk, video, self-talk + video, according to the mentioned above groups; subsession A), a 15 min standardized warm-up (subsession B), the practice of specific long jump drills for 50 min (subsession C) and finally, a 10 min standardized cool-down.

After the intervention was completed, at the 25th practice session, the posttest was conducted. In both evaluation sessions (pre- and posttests), a standardized warm-up (15 min) was carried out followed by one trial and one block of three maximal effort long jumps with a 20 m approach run; best jump distance (m) was taken into consideration. All trials were video recorded to examine specific kinematic variables. The approach run distance was selected taking into consideration that young athletes’ length of the positive acceleration phase is shorter compared with elite sprinters (Letzelter, 2006) as well as that they achieve maximum horizontal velocity at about 20 m from the starting point (Klimmer, 1999).

Intervention Program (Subsession A)

The ‘self-talk group’ (N = 18), during the 15-min intervention program, implemented self-talk. The instructional self-talk regimen (cue words related to technique elements of each drill) was administered by the use of written scripts (Hill & Borden, 1995; Smith & Holmes, 2004). Before every training session, participants were informed about their training program (drills they would perform during Subsession C) and read the written scripts for every drill, focusing on the important aspects of the movement. During the Subsession C, they were reminded of the self-talk regimen and were instructed to repeat the predetermined cue words before each trial.

The ‘video group’ (N = 16), during the 15-min intervention program, watched videos of a skilled model performing the long jump drills of Subsession C. Each video presented the performance of the drill eight consecutive times (Carroll & Bandura, 1990; Feltz, 1982). The specific number of consecutive demonstrations was selected taking into consideration the complexity of the motor task, the length of the practice period and the age of the participants. The observation of the model was not accompanied by any verbal instructions. During Subsession C, participants were instructed to recall the images of the movements they observed earlier in videos.

The ‘self-talk + video group’ (N = 18), during the 15-min intervention program, combined self-talk and observational learning (through video observation). Following a similar procedure to that of the previous group, participants watched videos of a skilled model performing the long jump drills of Subsession C. Each video presented the performance of the drill eight consecutive times. In addition, they read the self-talk scripts for each drill. During Subsession C, participants were instructed to repeat the cognitive self-talk regimen and recall the images of the movements they observed in videos.

The ‘control group’ participants (N = 17) received no intervention (no Subsession A) and therefore left stadium about 15 min earlier than the other three groups.

The self-talk scripts were specific for each long jump segment taught and each long jump drill had its own self-talk regimen (Appendix 1; ex. the ST statements administered in practice sessions 1–7 related only to the run-up, those administered in practice sessions 8–14 related only to the takeoff phase). Each practice session was characterized by different training program, consisting either of the instruction of new drills or the repetition of already learned drills. Consequently, in every practice session, participants either learned new self-talk cues or repeated those that had already “acquired”. Before and during the execution of each drill, participants should repeat all the self-talk cues related to the drill. During the last practice sessions (22nd-24th), participants executed
complete long jumps, repeating specific self-talk statements that had already “acquired”. ‘Self-talk’ and ‘self-talk + video’ groups read the same self-talk scripts. Every training session had also its own set of videos (ex., the demonstrations presented in practice sessions 1–7 related only to the run-up). The technically skilled model was an elite male long jumper (age = 23 years, best performance = 8.12m).

Self-talk scripts were developed according to the following procedure. Three jumping events’ coaches were interviewed and asked to describe the most important technical elements of the drills integrated in the instructional—training program as well as to refer the directions they give their athletes, concerning the execution of each drill. In addition, young athletes who had been taught long jump during the previous year were asked to describe, in their own words, the specific long jump drills. Taking into consideration the above data, the designing and implementation of verbal cues was based on Landin’s (1994) suggestions according to which verbal cues “must conform to the unique features of each instructional setting”, they have to be precise and concise, as well as logically associated with the task; verbal cues should also conform to the natural rhythm of the skill.

**Intervention Program Manipulation Check**

As a treatment integrity check, participants who used self-talk, upon completion of training session 7th, 14th, 21st, and posttest, were administered questionnaires to assess adherence to the use of the self-talk scripts as well as to examine the perceived effectiveness of cognitive self-talk. Concerning the frequency and content of self-talk, the following questions were used: a) “How often did you repeat self-talk statements before executing the exercise/during skill execution?” b) “Which self-talk statements did you repeat?” Participants were given a detailed list of the already used self-talk statements for each drill, for each long jump segment, to report the frequency of using each statement. They responded on each statement using a 5-point scale ranging from never to always. To assess the perceived effectiveness of self-talk, the four items representing its cognitive function of the Self-Talk Questionnaire for Sports (S-TQ: Zervas et al., 2007) were used, as well as the following question “Do you think that self-talk intervention assisted you in performing better?”. Participants responded on each statement using a 5-point scale ranging from nothing at all to very much.

Upon completion of the posttest, all participants, irrespective of the intervention program, were administered a questionnaire to assess whether their thoughts during Subsession C were associated with the task at hand or not. The above questionnaire consisted of 9 statements, based on S-TQ (Zervas et al., 2007), in which participants responded according to a 5-point scale ranging from never to always. Questionnaire assessed if participants were thinking about the technical elements of each drill, how they could correct mistakes, about directions they should provide themselves for better skill execution or their thoughts were confused or irrelevant to the examining task.

**Specific Long Jump Drills (Subsession C)**

The tutoring and practicing of the motor skill took place in the ‘real’ environment (Rose, 1997) where long jump is actually performed. As long jump is divided into four manageable segments (approach run, take-off, flight, and landing) performed successively, the “progressive part” teaching method was selected (Woods, 1998). This entails practicing each segment of the skill until it is sufficiently established and then connect each segment with the next one because the successful start of each part depends on the accurate completion of the previous one (Woods, 1998). The number of training sessions assigned for the tutoring of each segment was based on the recommendations made by the current literature (Hay, 1993; Klimmer, 1999; Linthorne et al., 2005) regarding the contributing factors of success in the event. The drills for each session were selected from the coaching literature (Klimmer, 1999; Korchemny, 1994; LeBlanc, 2001; McFarlane, 1994; Rubin, 2000; Seners, 1996) and aimed not only to improve the young athletes’ motor ability but also to contribute in the learning of the distinct segments of the long jump (Appendix 1).

**Instruments**

In both pre and post tests, a JVC GZ-HD6 video camera operating at 50frames/sec was used to record the touchdown and takeoff phase of the jumps. The camera was placed perpendicular to the long jump runway and in line with the front edge of the takeoff board, about 6.50m from it. The field of view of the camera was zoomed so that the young athlete was visible from the first contact of the last stride before takeoff, through to about 2m after takeoff (Linthorne et al., 2005). The movement space was calibrated with two 2.10m high poles that were placed in measured locations. These markers served as a basis for determining an appropriate linear scale.

The “Peak Motus” (Version 8) Performance Analysis System was used for analyzing the video images of the jumps. Twenty-one body landmarks that defined a 14-segment model were digitized in each image. The segmental data used were those proposed by Plagenhoef, Evans and Abdelnour (1983) for male and female adults. The two-dimensional coordinates of the body landmarks and the athlete’s center of mass were calculated from the digitized data, using the direct linear transformation (DLT) algorithm. Each jump was digitized two times and the average of the processed data were taken to reduce errors.

The instant of touchdown was defined as “the first clear frame in which the take-off foot was in contact with the ground”, and the instant of take-off was “the first clear frame in which the take-off foot was observed to break contact with the ground” (Hay, Miller, & Canterna, 1986; Lees, Graham-Smith, & Fowler, 1994). Maximum knee flexion was chosen to be a suitable indication of the
point at which the leg goes from compression (by way of eccentric muscular contraction) to extension (by way of concentric muscular contraction; Lees et al., 1994). The run-up speed of the athlete was taken as “the horizontal speed of the athlete’s centre of mass at the instant of touchdown”, and the take-off speed was calculated from the horizontal and vertical speed of the center of mass at the instant of take-off. The values of the kinematic variables examined in the current study (results presented in Table 1) have derived by calculations made directly by the “Peak Motus” software. A fiberglass tape was used to measure long jump distance, which is the perpendicular distance from the take-off line to the break in the landing area nearest to the take-off line (IAAF, 2004).

Data Analysis

A multivariate analysis of variance (MANOVA) was conducted to test for differences between groups in the pretest. Due to the existing differences in the pretest, analysis of Covariance (ANCOVA) was conducted to examine the influence of the experimental treatment on kinematic variables and on long jump performance, taking as covariate the pretest measurements. Effect sizes using partial eta2 were also obtained for each dependent variable. Post hoc analysis was performed using Bonferroni test. In addition, Pearson’s product—moment correlation coefficients (r) were used to investigate possible relationships between kinematic variables and performance. To assess adherence to the use of self-talk scripts as well as to examine the perceived effectiveness of instructional self-talk, mean scores were calculated. Repeated-measures ANOVA were also used to examine possible differences concerning the frequency of use of the self-talk cues among the four successive administrations of the questionnaires (practice sessions 7, 14, 21, posttest). Finally, MANOVA was used to test for possible differences concerning participants’ thoughts’ content among the four groups (questionnaire administered upon completion of the posttest).

Results

Performance and Kinematic Variables

The descriptive statistics (means and standard deviations) for kinematic variables and performance scores are presented in Table 1.

MANOVA’s results revealed significant differences between groups (Wilks’s Λ = .584, F (21.170) = 1.664, p = .041, partial η² = .164). More specifically, statistically significant differences were found for the following variables: ‘horizontal velocity at the instant of touchdown on the board’ (Vxtd; F(3.65) = 8.672, p < .001), ‘speed at takeoff’ (Vr; F(3.65) = 5.027, p = .003) and ‘height of center of mass during the touchdown last-but-one-stride’ (hcmto; F(3.65) = 3.243, p = .029). Post-hoc analysis was performed using Bonferroni test (Table 1).

The results of ANCOVA revealed that the main effect of the factor “practice mode” on performance improvement was significant (F(3.64) = 6.437, p < .01, η² = .232), with the “self-talk” group presenting significantly better performance in the posttest, compared with the other three groups (ST vs V: mean difference = 0.220 m, p = .011, ST vs ST+V: mean difference = 0.183 m, p = .042, ST vs control: mean difference = 0.267 m, p = .001). Concerning the ‘horizontal velocity at the instant of touchdown on the board’ (Vxtd), ANCOVA’s results revealed that there were no significant differences among the four groups, in the posttest (F(3.64) = 2.147, p > .05, η² = .091). Similarly, no significant differences were found among the four groups concerning the ‘speed at takeoff’ (Vr; F(3.64) = 0.456, p > .05, η² = .021). Although ANCOVA’s results presented significant differences for the vertical velocity at the instant of takeoff (Vyto; F(3.64) = 3.252, p = .027, η² = .132), post hoc comparisons revealed that there were no significant differences among the four groups (ST vs V: mean difference = -2.26 × 10⁻⁵ m/sec, p = 1.000, ST vs ST+V: mean difference = 0.233 m/sec, p = .251, ST vs control: mean difference = 0.276 m/sec, p = .110, V vs ST+V: mean difference = 0.233 m/sec, p = .298, V vs control: mean difference = 0.276 m/sec, p = .144, ST+V vs control: mean difference = 0.044 m/sec, p = 1.000). Concerning the height of center of mass during the touchdown last-but-one-stride and contact phase, significant differences were found among the four groups (hcmto; F(3.64) = 33.344, p < .001, η² = .654, hcmtdl: F(3.64) = 99.280, p < .001, η² = .823, hcmkmkf: F(3.64) = 103.640, p < .001, η² = .829, hcmtdo: F(3.64) = 98.942, p < .001, η² = .823). Post hoc comparisons showed that the groups with the video modality (V and ST+V) presented significantly higher center of mass position compared with ST and control group (p < .001; Table 1).

Relationships between kinematic variables and performance are given in Table 2. Even though the participants of the current study were young, beginner athletes, significant correlations were found between the horizontal velocity at the instant of touchdown on the board (Vxtd) and performance (r = .288, p = .016) as well as between the speed at takeoff (Vr) and performance (r = .267, p = .026). The vertical velocity at the instant of takeoff was not significantly correlated with long jump performance (r = .044, p = .721).

Questionnaires’ Results

To assess adherence to the use of self-talk scripts as well as to examine the perceived effectiveness of cognitive self-talk, mean scores were calculated (Table 3). It seems that during the intervention program (24 practice sessions) young athletes practiced self-talk with consistency and used self-talk regimen quite often. Regarding the perceived effectiveness of self-talk, participants believed that self-talk helped them to be more concentrated at the task at hand, to give themselves directions, to correct mistakes and reminded them, as well, of the technical
Table 1 Descriptive Statistics (means and SD) for Performance Scores and Kinematic Variables

<table>
<thead>
<tr>
<th>group</th>
<th>Performance (m)</th>
<th>Vxtd (m/sec)</th>
<th>Vyto (m/sec)</th>
<th>Vr (m/sec)</th>
<th>Hcmlbos (m)</th>
<th>Hcmtd (m)</th>
<th>Hcmmkf (m)</th>
<th>Hcmto (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>self-talk</td>
<td>2.64 ±0.33</td>
<td>3.07h,i</td>
<td>7.19c,e</td>
<td>7.53</td>
<td>1.69</td>
<td>2.05</td>
<td>7.03</td>
<td>7.16</td>
</tr>
<tr>
<td>video</td>
<td>2.86 ±0.35</td>
<td>3.03b</td>
<td>8.31d</td>
<td>8.58</td>
<td>1.81</td>
<td>2.09</td>
<td>7.71f</td>
<td>7.73</td>
</tr>
<tr>
<td>self-talk + video</td>
<td>2.84 ±0.37</td>
<td>3.05i</td>
<td>7.96b</td>
<td>8.45</td>
<td>1.69</td>
<td>1.81</td>
<td>7.52c</td>
<td>7.42</td>
</tr>
<tr>
<td>control</td>
<td>2.60 ±0.36</td>
<td>2.77j</td>
<td>7.12b</td>
<td>7.48</td>
<td>1.60</td>
<td>1.74</td>
<td>6.66c</td>
<td>7.03</td>
</tr>
</tbody>
</table>

Note: Superscripts indicate significant differences between groups: a p=.037; b p=.020; c, d p=.001; e p=.028; f p=.006; g p=.041; h p=.011; i p=.042; k,l,m,n,p,q,r,s,t,u,v,w,x,y,z p<.001

Vxtd: horizontal velocity of the athlete's center of mass (CM) at the instant of touchdown on the board.
Vyto: vertical velocity at the instant of takeoff.
Vr: speed at takeoff
Hcmlbos: height of the CM during the touchdown at the last-but-one-stride.
Hcmtd: height of the CM during the touchdown at the contact phase.
Hcmmkf: height of the CM during maximum knee flexion at the contact phase.
Hcmto: height of the CM during takeoff at the contact phase.

Vxtd: horizontal velocity of the athlete's center of mass (CM) at the instant of touchdown on the board.
Vyto: vertical velocity at the instant of takeoff.
Vr: speed at takeoff
Hcmlbos: height of the CM during the touchdown at the last-but-one-stride.
Hcmtd: height of the CM during the touchdown at the contact phase.
Hcmmkf: height of the CM during maximum knee flexion at the contact phase.
Hcmto: height of the CM during takeoff at the contact phase.
elements of each drill. Repeated-measures ANOVA revealed significant differences concerning the frequency of repeating the self-talk cues before executing the exercise between the 4th administration of the questionnaire and each of the previous one. The results of the analysis are presented in Table 3.

MANOVA’s results revealed no significant differences concerning participants’ thoughts’ content among the four groups (Wilks’s Λ = .715, F(27.167) = 0.755, p = .803). Irrespective of the intervention program, all participants’ thoughts were relevant to the content of the training program.

**Discussion**

The purpose of the current study was to examine the contribution of instructional self-talk and observational learning on the development of long jump technique. Results presented a significantly higher performance improvement for the self-talk group in posttest, whereas when the center of mass displacement was assessed observational learning proved to be more effective. For the parameters related to the velocity achieved during the approach run (Vxtd) and the resultant velocities at takeoff [vertical velocity (Vyto), speed at takeoff (Vr)], no significant differences were found among the four groups.

The ‘self-talk’ group demonstrated significantly higher performance improvement compared with the other three groups, in the posttest. Self-talk probably helped young athletes to direct and maintain attentional focus on the most critical elements of each segment of the motor skill (Cutton & Landin, 2007; Hardy et al., 2001; Hatzigeorgiadis, 2006; Hatzigeorgiadis, Zourbanos, & Theodorakis, 2007; Mallett & Hanrahan, 1997; Zervas et al., 2007; Zinsser et al., 2001). Taking into consideration that long jump consists of four manageable segments, performed successively as a complete “flowing” movement, the above findings confirm the value of self-talk in initiating the entire movement sequence (Cutton & Landin, 2007; Landin & Hebert, 1999), as well as in contributing to the learning of a new motor skill. Bandura (1977) considers “the sequencing of component skills to be characteristic of ‘learning’ a new skill even though each of those skills already exists in the motor repertoire of the children”. According to McCullagh et al. (1990), the verbal rehearsal of the sequence before performance was the crucial difference in the ability to reproduce the sequence of already learned skills in a predetermined order. In addition, self-talk technique appeared to help the performers’ development and execution of motor plans by verbally providing a guide for the critical parts of a motor task (Cutton & Landin, 1999, 2001). The implementation of cue words, designed for the instruction of long jump, permits verbal coding and allows the formation of a more information-rich symbolic representation from which motor actions could accurately be reproduced (Janelle et al., 2003; McCullagh et al., 1990).

Depending on whether quantitative or qualitative aspects of movement are under examination, different coding mechanisms (visual coding through observational learning and verbal coding through self-talk) may operate, underlining the critical aspects of task requirements to ensure maximal motor performance reproduction (McCullagh et al., 1990; Wiese-Bjornstal & Weiss, 1992). When kinematic variables (displacement of the height of the center of mass) of long jump were assessed, results revealed that the groups with the video modality (V and ST+V) presented significantly higher center of mass position compared with the other groups (Figure 1). Similar to elite athletes’ movement pattern, the body center of mass reached its lowest point at touchdown (contact phase), and then it appeared to rise immediately after touchdown.
**Figure 1.** Height of the Centre of Mass Position in the Post-Test

**Table 3 Mean Scores and Standard Deviations Concerning the Frequency of Use of the ST Cues and the Perceived Effectiveness of Cognitive ST**

<table>
<thead>
<tr>
<th>variables</th>
<th>1st administration (7th training session)</th>
<th>2nd administration (14th training session)</th>
<th>3rd administration (21st training session)</th>
<th>4th administration (post-test)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Mean</td>
<td>Mean</td>
<td>Mean</td>
</tr>
<tr>
<td>frequency of use a</td>
<td>3.94a ±1.07</td>
<td>4.08b ±0.97</td>
<td>4.08c ±0.97</td>
<td>4.42a,b,c ±0.84</td>
</tr>
<tr>
<td>frequency of use b</td>
<td>3.22 ±1.24</td>
<td>3.39 ±1.34</td>
<td>3.47 ±1.32</td>
<td>3.64 ±1.20</td>
</tr>
<tr>
<td>cognitive a</td>
<td>4.50 ±0.70</td>
<td>4.61 ±0.60</td>
<td>4.50 ±0.74</td>
<td>4.56 ±0.65</td>
</tr>
<tr>
<td>cognitive b</td>
<td>4.19 ±0.92</td>
<td>4.31 ±0.89</td>
<td>4.47 ±0.70</td>
<td>4.53 ±0.77</td>
</tr>
<tr>
<td>cognitive c</td>
<td>4.19 ±1.01</td>
<td>4.17 ±0.91</td>
<td>4.44 ±0.81</td>
<td>4.22 ±0.96</td>
</tr>
<tr>
<td>cognitive d</td>
<td>4.42 ±0.73</td>
<td>4.58 ±0.60</td>
<td>4.47 ±0.77</td>
<td>4.56 ±0.73</td>
</tr>
<tr>
<td>performance</td>
<td>4.42 ±1.00</td>
<td>4.61 ±0.73</td>
<td>4.56 ±0.73</td>
<td>4.53 ±0.77</td>
</tr>
</tbody>
</table>

Note: Superscripts indicate significant differences among the administrations: a, c p<.05; b p=.05

frequency of use a: How often did you repeat ST statements before executing the exercise?
frequency of use b: How often did you repeat ST statements during skill execution?
cognitive a: Do you think that ST intervention assisted you in giving yourself directions?
cognitive b: Do you think that ST intervention assisted you in focusing more fully at the task at hand?
cognitive c: Do you think that ST intervention assisted you in reminding yourself about the technical elements of each drill?
cognitive d: Do you think that ST intervention assisted you in correcting mistakes?
performance: Do you think that ST intervention assisted you in performing better?
through maximum knee flexion, to takeoff with most of the increase occurring between the last two phases (Lees, Fowler, & Derby, 1993; Lees et al., 1994).

Although long jump is a power-based skill, the results of the current study are not in agreement with those of Edwards et al. (2008) and Tod et al. (2009) who had come to the conclusion that self-talk intervention (especially motivational self-talk) led to greater center of mass displacement and to increased jump height in vertical jump task. The different results may be due to the nature of the examined tasks and their different motor demands (Hatzigeorgiadis et al., 2011). Specifically, long jump is a complete, complex skill, consisting of four manageable segments performed successively, requiring coordination, accuracy, and power, while vertical jump is a simple movement, requiring power, where participants had to bend and jump as high as possible. An other possible reason for these different results might be the different age of participants. In the two studies where vertical jump was examined, participants were adults, rugby players or active individuals, characterized by more mature, stable movement patterns, whereas in the current study participants were young, beginner athletes, whose performance was most likely characterized by greater variation. The nature of the examining task in relation to the age of participants could also explain the above mentioned differences. Considering the improvement of the horizontal velocity at the instant of touchdown on the board (Vxtd) in the posttest (although not statistically significant compared with the other experimental conditions), we could speculate that self-talk intervention might have influenced cerebral cortex functioning and muscle activation, leading to an improvement of mobility and technique of sprinting, in young athletes. However, the insufficient strength level of youngsters did not permit the maintenance of that horizontal velocity during the takeoff phase, affecting this way the technique execution during the flight phase of the jump (Malina, Bouchard, & Bar-Or, 2004).

Moreover, considering the type of intervention in combination with the skill level of the participants we could argue about the different findings of the three compared studies. Edwards et al. (2008) speculate that experienced individuals benefit from motivational self-talk cues, as this type of self-talk reminds athletes of the outcome and not about the technical aspects of the movement, thought which may disrupt performance especially in high speed activities (Coker, Fischman, & Oxendine, 2006). Untrained individuals, in Tod et al.’s (2009) study, appeared to benefit from both instructional and motivational self-talk in different ways. Instructional self-talk may have increased power generation in vertical jumping by directing subjects’ attention to those aspects of the movement that can directly influence execution, whereas motivational self-talk enhanced effort (Hatzigeorgiadis, 2006) and energy expenditure (Theodorakis et al., 2000). Similarly to untrained individuals, young beginner athletes are characterized by less well-developed movement patterns and neural pathways that might be modified in different ways by various cognitive interventions. The findings of the current study revealed that instructional self-talk intervention led to an improved long jump performance suggesting self-talk usefulness for tasks that could be “broken down” into related and segmented parts, whereas observational learning was more effective in enhancing the “quality” of movement (McCullagh et al., 1990) (higher position of the center of mass during the takeoff phase). Learners, according to Bandura’s theory, form a cognitive representation of the observed model’s performance that subsequently guides their overt movements. With increased observation of the model and increased practice trials, subjects better recognize correct form and perform more like the model (Wiese-Bjornstal & Weiss, 1992).

No significant differences were found among the four groups for any of the parameters related to the velocity achieved during the approach run (Vxtd) and the resultant velocities at takeoff (Vyto, Vr), in the posttest. The fact that the three experimental groups did not improve compared with the control group might be due to the intervention’s characteristics. Participants who observed in videos the execution of long jump drills received information for limbs and body movements. Although visual demonstrations are considered to be valuable means of offering important task-relevant information to learners, ‘observational learning’ was not more effective compared with the other learning modalities in providing information concerning power generation and consequently the development of the appropriate horizontal and vertical velocity. Even though instructional self-talk regimen provided very elaborate instructions concerning the technique elements of the run-up and the takeoff phase, probably it could not enable beginner athletes to understand and focus on notions expressing explosive strength like “acceleration”, “maximum velocity”, “converting the horizontal velocity into vertical one”. The execution of several segments of the jump and long jump performance as well may be influenced by both power and technique. Literature reports that motivational self-talk has greater impact on effort (Hatzigeorgiadis, 2006) and is related to better performance in sports requiring power-based skills (Edwards et al., 2008; Hatzigeorgiadis, Theodorakis, & Zourbanos, 2004; Tod et al., 2009).

In the current study, self-talk intervention included only instructional self-talk statements focusing on technique elements of each segment. The use of motivational self-talk statements could probably lead to different results concerning velocity parameters. Wulf (2007) and Wulf & Prinz (2001) suggested that directing peformers’ attention to the effects of their movements (an external focus of attention) may be more beneficial than directing their attention to their actual movements (an internal focus of attention). An external focus may allow automatic control processes to regulate movements, whereas an internal focus may interfere with natural control processes (Wulf & Prinz, 2001). However, the results of the current study cannot support the suggestion that instructional self-talk disrupted performance through focusing participants’
attention on movement characteristics. Other variables may have mediated the influence of self-talk on velocity parameters, such as self-efficacy, information and cognitive processes, imagery and attention (Hardy, 2006). For youngsters or beginners, their time and capacity to process critical information is limited (Magill, 2004). In addition, the attention and retention subprocesses are limited in young novice participants (Ste-Marie et al., 2002) and elementary students (Feltz, 1982). In keeping with Hardy’s (2006) recommendation, research is needed to explore the psychological variables that mediate any influence self-talk or observational learning may have on performance.

The combination of ‘self-talk’ and ‘observational learning’ did not present significant differences compared with the other learning modalities. Combining verbal and visual cues was expected to facilitate attention to the most critical aspects of the movement and to enhance retention of the observed action through the formation of more elaborate visual and verbal codes (Janelle et al., 2003). The fact that the participants of the ‘self-talk + video’ group did not present a significantly improved skill performance might be due to the ‘complicated’ combination of this learning modality. Participants had to recall the images of the observed movement, repeat the self-talk regimen and perform the drills for the ‘acquisition’ of a complex motor skill, combination which may have exceeded their developmental capabilities (Weiss, 1983).

At this point, it would be appropriate to mention an issue that might interfere with the results of the current study. The fact that the control group left 15min earlier, than the experimental groups, as it received no intervention might be considered as a confounding factor. According to participants’ answers to the questionnaire administered upon completion of the posttest (see Intervention Program Manipulation Check), it appears that irrespective of the intervention program, all participants’ thoughts were relevant to the content of the training program. Thus, although control participants received no intervention, their thoughts during the training sessions (subsession C) were associated with the execution of the motor skill. However, the effect of a “placebo” task included for the control group should be examined in future research to eliminate possible confounding factors.

## Conclusion

A significantly higher performance improvement was recorded for the self-talk group in posttest, whereas participants who observed in video the skill execution achieved significantly higher center of mass position. Moreover, no significant differences were found among the four groups for the parameters related to the velocity achieved during the approach run and the resultant velocities at takeoff. These findings suggest that instructional self-talk is useful for tasks that could be “broken down” into related and segmented parts, especially in the early stages of learning, and confirm its value in directing and maintaining an athlete’s attentional focus on the most critical elements of each segment of the motor skill. “Observational learning” proved to be more effective when kinematic variables of the motor skill (center of mass displacement) were assessed. Considering that young children may have less well-developed movement patterns and neural pathways that might be modified by cognitive interventions, they could benefit more from cognitive intervention techniques such as self-talk and observational learning. Though, future research should examine the influence of both types of self-talk in combination with different learning techniques on kinematics and performance on “complete complex skills” requiring coordination, technique and power, such as jumping events or hurdles, during the early stages of learning. In addition, the specific kinematic characteristics in relation to young athletes’ strength levels should be examined in future research to extend knowledge on how cognitive techniques may influence skill execution. The above information may be important for coaches and educators in designing and directing related programs for young, beginner participants, aiming in the improvement of motor abilities and skill performance through the enhancement of the proper perceptual abilities.

## References


## Appendix 1  Training Program and Self-Talk Regimen

<table>
<thead>
<tr>
<th>Practice sessions</th>
<th>Purpose</th>
<th>Exercises</th>
<th>Self-talk regimen</th>
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<td>Approach phase</td>
<td>High knee skipping</td>
<td>Straight leg Push forward</td>
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<tr>
<td></td>
<td>Learning the appropriate running technique</td>
<td>Low knee skipping</td>
<td>High knee lift - thigh parallel to the ground Torso erect Push forward Knees low and fast</td>
</tr>
<tr>
<td></td>
<td>Development of the appropriate horizontal velocity</td>
<td>Rear kicks</td>
<td>Torso erect Push forward</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Leg shuffle</td>
<td>Heels to the buttocks Straight leg</td>
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<tr>
<td></td>
<td></td>
<td>Acceleration 30-40m</td>
<td>Push up on the toes First steps long Increase speed progressively</td>
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<tr>
<td>8th - 14th</td>
<td>Learning the takeoff phase</td>
<td>Setting the takeoff leg for takeoff</td>
<td>Strike/ “paw” the ground Push forward</td>
</tr>
<tr>
<td></td>
<td></td>
<td>High knee skips with bounds</td>
<td>Strike/ “paw” the ground Push high and forward Look forward and up</td>
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<tr>
<td></td>
<td></td>
<td>Long jump takeoff with 1/3 strides</td>
<td>Strike/ “paw” the ground - push off Torso erect High knee lift - thigh parallel to the ground Push high and forward - stay in the air Landing on the leading leg</td>
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<tr>
<td>15th - 18th</td>
<td>Connect the approach run with the takeoff phase</td>
<td>Approach running</td>
<td>First steps long Increase speed progressively</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Takeoff from different length run-ups</td>
<td>First steps long Increase speed progressively Strike/ “paw” the ground Torso erect Push high and forward Stay in the air</td>
</tr>
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<td>19th -20th</td>
<td>Learning the flight phase</td>
<td>Takeoff from 6/ 8 running steps</td>
<td>First steps long Increase speed progressively Strike/ “paw” the ground Torso erect Push high and forward Stay in the air Landing on two legs</td>
</tr>
<tr>
<td>21st</td>
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<td>Landing into the pit</td>
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<tr>
<td>22nd - 24th</td>
<td>Complete long jumps</td>
<td>Short/ medium/ full approach single-stride long jumps</td>
<td>First steps long Increase speed progressively Strike/ “paw” the ground Torso erect Push high and forward - stay in the air Both legs extended forward Swing arms behind the trunk</td>
</tr>
</tbody>
</table>