Neural Control of Movement

Read or listen? Effects of different kinds of instruction on the learning of a sport motor skill

Edson Jorge Chambal[1], Domingos Manuel Nhamussusa[1], Matheus Maia Pacheco[2], Ricardo Drews[3], Go Tani[4]

[1]Pedagogical University of Mozambique, Maputo, Mozambique; [2]Universidade do Porto, Centro de Investigação Formação Inovação e Intervenção em Desporto, Porto, Portugal; [3]Universidade Federal de Uberlândia, Uberlândia, MG, Brazil; [4]Universidade de São Paulo, São Paulo, SP, Brazil.

Associate Editor: Marcela de Castro Ferracioli Gama, Universidade Federal do Ceará, Fortaleza, CE, Brazil. E-mail: marcelaferracioli@gmail.com.

Abstract - Aim The present study investigated the effects of different instruction types (verbal and written) in the motor learning of a sport skill. **Methods:** Twenty-three volunteers, from both sexes, 12,96 ± 1.1 years of age, were distributed in two groups: verbal instruction (GIV) and written instruction (GIE). The task was to perform the basketball layup without the ball touching the hoop. All participants performed five baseline trials on the free-throw for balancing initial group performance between groups. Then, they performed 32 practice trials and a retention test of 8 trials a week later on the basketball layup. T-tests were used to compare the groups in baseline and retention tests. **Results:** The results showed, in both practice and retention, superior performance for GIE compared to GIV. **Conclusion:** We conclude that providing written instructions benefited the performance and learning of a sport motor skill.

Keywords: motor behavior, motor learning, basketball, adolescents.

Introduction

Considering the different aspects that can affect the acquisition of motor skills (e.g., practice schedule, feedback, goal establishment), instruction (mode of presentation and content) is an ongoing focus for researchers in motor learning[1-3]. Instruction is still the main tool used to help the learner to comprehend the task goal, guide to the most appropriate movement solutions - be it in terms of a description of the action or a cue[4,5].

One of the most common forms to present instructions is through verbal expression. Verbal communication requires the listener/learner to be able to hear the content of the instruction, maintain attention over some time span as to perceive/understand the information that is being provided, and act in terms of it. However, instructions can be provided through writing (reading), something that has been left aside by researchers[6]. Like verbal instruction, the learner must be able to read the written information and, understanding it, turn it into action[7].

Studies on verbal and written instructions in motor learning did not compare these types of instruction yet - they have been considered in conjunction to demonstration[8,9,10]. For instance, Públio et al.[9] showed that demonstration and demonstration with added verbal instructions resulted in better results than just verbal instruction in learning eight gymnastics exercises. In the same vein, Reo and Mercer[10] showed worse results in learning other gymnastic exercises for written instructions compared with a live skilled model, a videotape of a skilled instructor with a model who demonstrated errors and correction, and a skilled model in an error-free videotape.

Some researchers[6,11] have suggested that the effects of verbal instructions are dependent on the level of skill acquisition of the learners. Verbal instructions would be effective, for instance, when the learner is novice at the task - still unaware of the critical aspects of the task (e.g., goals and rules). However, such suggestion must be considered in terms of the of the learner's ability to use such information presented in the instructions. Specifically, instructions with too many aspects (content) might create an overload of information which diminish motor learning outcome[12,13]. Thus, the processing time of the received information that the learner has to assimilate the critical aspects of the task can influence the use of this information, since the control of the supply of information is carried out by the information sender (e.g., coach, teacher). In this way, written instructions becomes an interesting alternative to verbal instructions. Written information decreases time constraints on the learner's own processing and

"translating" information into movement control given the message medium maintains information. However, there are no studies to date that have tested which of these two types of instruction would be more effective for motor learning.

Thus, the present study compared two types of instruction (written and verbal) in learning the basketball skill of layup throw. Despite the lack of studies comparing written and verbal instructions effects in motor learning, we hypothesize that, given the presented rationale, written instructions will lead to greater gains in motor learning compared to verbal instructions.

Methods

Sample

Twenty-six adolescents from a school in Maputo (Mozambique) (14 girls; all right-handed, 12.96 ± 1.1 years of age) participated in the study. The sample for this study was a convenience sample from two different classes from the same school. Three participants were excluded from the sample given they did not participate on all stages of the study. All participants had no previous experience in the task. All adolescents' legal guardians signed an informed consent form after being instructed about the study's procedures and participants' rights. The project was approved by the ethics committee of Physical Education and Sport College of Mozambique Pedagogical University (n° 104/CNBS).

Instruments and task

Participants' task was to perform a layup, using the basketball backboard, with the goal to score with the ball not touching the hoop. The movement included the following steps. First, the participant would run, from a line of participants, in a slow pace at a 45° angle from the backline of the court in direction to the experimenter. The experimenter would be positioned at 3 m from the hoop with his left arm raised with the ball in his hand. Second, the participant would get the ball, give two more steps (first with his right foot), and jump elevating his/her knee and right arm. Third, the participant would throw the ball with his elbow still extended and flexing his wrist. After the throw, the participant would recover the ball and return dribbling to the end of line (Figure 1).

We employed a modified version of AAHPERD[14] precision test[15]. The scoring system attributed 6 points for balls scored without touching the hoop or the backboard; 5 points to balls scored touching first on the hoop; 4 points for ball scored touching first the backboard; 3 points for ball that only touches the hoop; 2 points to balls that only touches the backboard; 1 point to balls that neither touch the hoop nor the backboard; and 0 points to throws that were preceded by a fault (e.g., making more than two steps, or dribbling before the throw). All throws were performed coming from the right side of the court.

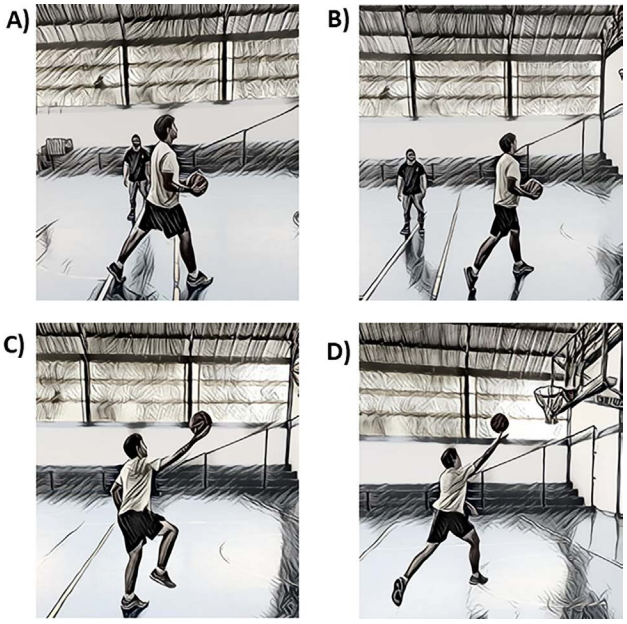

Figure 1 - Basketball layup task image.

Procedures

Participants were divided into two groups: verbal instruction group (GIV; n = 10) and written instruction group (GIE; n = 13). The study was composed of a baseline (5 trials), an acquisition phase (32 trials), and a retention test (8 trials).

The baseline was used to guarantee similar performance at the beginning of the experiment. All participants performed a single block of 5 throws, two meters away from the backboard, with the instruction "throw the ball to score" with no extra information about how to perform the skill. From the baseline score, the participants were ranked and distributed in both experimental groups according to their performance. After seven days, the participants performed the acquisition phase. Before the experiment, the experimenter provided all information about the objective of the task, layup scoring system, number of attempts and an image illustrating the throw.

Then, the GIV group received, verbally, the following instructions about the motor skill three times consecutively: (1) run slowly in the direction to the ball; (2) get the ball, step first with the feet of the same side of the hand that will perform the throw; (3) perform the second step with the contrary feet and raise the ball to the position of throw, flexing the knee of the leg of the first step; (4) start the vertical jump and finish with the throw to the hoop; (5) in the last part of the throw, extend the arm upward and flex the wrist; (6) dampen the jump landing with both feet by flexing both legs. The GIE received the

same instructions in a paper and were instructed to read out loud the instructions three times.

To perform the 32 trials in the acquisition phase, each group was organized in a row and the participants performed 4 blocks of 8 trials, divided into two days of practice - two blocks of trials per day. Instructions (verbal or written) were provided at the beginning of each block. One week after the acquisition phase, both groups performed the retention test. In this, participants performed a single block of 8 trials and no instructions were provided.

Statistical analysis

The throwing performance was calculated as the sum of scores of each block (4 for the acquisition phase, one for retention and one for baseline). The data distribution demonstrated to follow a normal distribution (Shapiro-Wilk's test).

We performed a Student's *t*-test for independent measures to compare the groups in the baseline. To test the effect of practice in performance, we performed an ANOVA two-way (2 groups x 4 blocks) with repeated measures in the second factor for the acquisition phase measures. Post-hoc analyses were performed with the Holm's sequential procedure. Finally, to test the effect of retention, we performed a Student's *t*-test for independent measures. All analyses were performed in JASP 0.14.1 and the significance level was defined as $p < 0.050$.

Result

Baseline

Figure 2 shows the groups' performance in the baseline, acquisition phase and retention test. The *t*-test revealed no significant differences between groups in the baseline (GIV = 14.80 ± 1.55; GIE = 15.68 ± 1.79; $t[21] = 1.24$; $p = 0.231$).

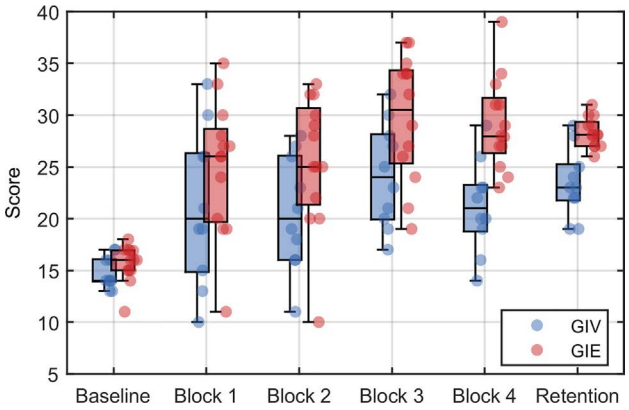

Figure 2 - Mean values of scores at Baseline, Acquisition Phase (Blocks 1-4) and Retention test in the written instruction group (GIE) and in the verbal instruction group (GIV).

Acquisition phase

The ANOVA revealed a significant main effect for blocks ($F[3, 63] = 4.85$; $p = 0.004$; $\eta_p^2 = 0.07$) and a significant main effect for groups ($F[1, 21] = 8.53$; $p = 0.008$; $\eta_p^2 = 0.18$). The analysis did not show a significant interaction between groups and blocks ($F[3, 63] = 17.27$; $p = 0.404$; $\eta_p^2 = 0.01$). The post-hoc revealed differences between the third block from the first and second blocks ($p = 0.011$; $p = 0.010$, respectively) and the GIE showed better results than GIV throughout practice.

Retention test

The Student's *t*-test revealed significant main effects for groups ($t[21] = -4.80$; $p < 0.001$; $d = 0.6$) The analyses showed that the GIE reached (28.33 ± 1.43) higher scores than GIV (23.40 ± 3.31).

Discussion

The issue of how to instruct learners is an ongoing concern of practitioners, coaches and researchers of movement sciences. The present study compared verbal and written instructions in the learning of the basketball layup throw. The results confirmed the study's hypothesis that written instructions would lead to superior performance and learning. The difference between groups was already apparent at the beginning of the acquisition phase and it was confirmed in the retention tests.

The lack of studies comparing specifically these two types of instruction in the acquisition of motor skills precludes discussion in terms of the literature. As mentioned in the introduction, most studies in the motor learning area compared the effects of modeling and demonstration with verbal instructions on motor skill acquisition[9,16-18].

Two lines of reasoning can accommodate the results observed in the present study. The first refers to differences in information processing generated by the type of instruction provided. Specifically, the short-span memory capacity to retain and organize information are related to processes speculated in working and short-term memory[18]. We can speculate that written instructions facilitate learning by releasing working and short-span memories from maintaining information for action execution. While written instructions are easily reassessed after a first reading, parts of verbal instructions would be lost provided a capacity-limited memory. Clearly, we consider that the instructions provided encompassed several aspects of the to-be-learned movement skill[19]. In this situation, there is an increased demand on the learner to organize and maintain information from an instructor. In other words, we consider that the participants inherent constraints directly interact with the effect of instructions.

The second line of reasoning refers to a potential increase in motivation through autonomy. Studies have been showing that increasing participants autonomy to

decide on some aspects of practice (e.g., when to receive knowledge of results, demonstration, the level of complexity of the task) can increase motivation and result in better result in learning tests[20]. Specifically, some studies have shown that the possibility of choosing simple aspects such as the color of the practice instruments[21] and a less controlling language (content) inducing greater freedom of learners can lead to gains in motor learning[22], as well as in the cognitive learning[23,24]. The GIE group - as an accidental consequence of the design - could control the reading time of the written instructions. This could be individually manipulated to match processing time and favored motivation through increased autonomy. Autonomy can lead to increased intrinsic motivation (inherent pleasure and satisfaction in performing the activity) and self-efficacy (perception of the capacity to achieve a given desired result) which is associated to learning benefits in a range of areas (including physical activity and sports)[25,26].

It should be noted, however, that the present study did not measure variables related to processing capacity or autonomy. This is a limitation of the present study and calls for further studies on the topic. It is also worthwhile considering that both groups improved in the task and the aforementioned rationale would probably predict a larger differences between groups. The fact that the participants of this study were already close to puberty might have alleviated the potential differences that would occur for younger children or other populations that are said to have limited processing capacities.

Conclusions

We conclude that providing written instructions benefited the performance and learning of a sport motor skill in adolescents. From consideration of the limited literature in this theme, we recommend further investigation trying to replicate and extend the current findings. These extensions include the addition of another age groups and direct measurement of motivational and processing variables to facilitate a better comprehension of our results.

Finally, this study presents an interesting alternative for coaches and physical education teachers to implement in their classes when teaching new skills. As written cards with instructions can be easily scaled to large groups, one can observe whether the implementation of written instructions would favor large group intervention.

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Corresponding author

Domingos Manuel Nhamussua. Pedagogical University of Mozambique, Maputo, Mozambique.
E-mail: dnhamussua@yahoo.com.br.

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