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Research Article

EFFECT OF VIDEO FEEDBACK ON "HOOP THROW" SKILL OF RHYTHMIC GYMNASTICS PRACTITIONERS IN DIFFERENT LEARNING STAGES

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HIGHLIGHTS
- Video feedback has positive effect on the complex motor learning for novices.
- Video feedback helps novices to accelerate the cognitive representation of action.
- Experienced learners do not improve performance when using video feedback.

ABBREVIATIONS

ANOVA	Analysis of variance
KP	knowledge of performance
RG	Rhythmic Gymnastics
GB	Group Beginner
GE	Group Experienced

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BACKGROUND: Video feedback has been considered important for learning complex motor skills. However, little is known about the effect of this type of visual feedback for learners in different stages of motor learning.
AIM: To analyze the effect of video feedback on "hoop throw" learning by beginner and experienced Rhythmic Gymnastics (RG) learners.
METHOD: Sixteen girls, aged 10-14 years, participated in the study, composing the Group Beginner (GB = 10 RG practitioners for a maximum of one year) and the Group Experienced (GE = 6 RG practitioners for at least two years). The study consisted of four experimental phases: Pre-Test, Acquisition, Post-Test, and Retention. Analyses of variance were used to compare the performance of each group between experimental phases.
RESULTS: For the GB, performance was significantly inferior in the Pre-Test compared to the performance in the Acquisition and Retention Phases, characterizing success in the learning process. For the GE, no significant performance differences were observed between experimental phases.
CONCLUSION: Video feedback has a positive effect on the complex motor learning process, especially for individuals in the initial stages of learning.

KEYWORDS: Visual feedback | Video | Learner | Rhythmic gymnastics | Motor learning

INTRODUCTION

The use of video feedback during practice has been shown to facilitate learning of several tasks, such as tennis service[1], swimming[2-4], balance beam routine[5], golf[6], and basketball set shot[7-8]. In addition, the benefits of video feedback have been observed under different conditions, such as when the video feedback is combined with verbal cues[7], when it is coupled with a model video[9], and when it is self-controlled[10].

The use of video feedback for motor learning became an accessible strategy in the 1960s, showing the learner's movement dynamics in detail and providing visual feedback during practice[11-12]. Video feedback is categorized as a type of motor performance augmented feedback. In the sports field, the augmented feedback on the learner performance (knowledge of performance - KP) has the function of instruction, motivation, and reinforcement[13]. Research in motor learning has demonstrated that the use of video feedback during practice benefits skill acquisition as it provides more information in less time[4], gives the learner greater understanding of movements performed through visual observation[14], and allows the learner access to information about their performance that they did not perceive during execution[5].

Given that practice and feedback are central parameters of the motor learning process, motor performance professionals should understand that exhaustive practice may not be enough to improve performance and that feedback should provide specific momentum, quantity, and focus [15-16], since the learner has several specificities about attention focus and concerns about performance[17]. It is up to the professional/teacher to identify difficulties presented by the learners so that specific strategies can be used correctly to motivate them during the motor learning process.

In general, learners in the initial stages are trying to acquire a cognitive representation of action, do not know which elements of action to focus on, and have concerns about movement pattern. On the other hand, experienced learners have a cognitive representation of action, and can direct their attention to relevant information on action and adjustments in motor control[12-13, 17].

In a meta-analysis study on the use of visual feedback in motor learning, Rhoads et al.[12] showed that there is a gap in understanding the benefits of providing this kind of feedback to beginner and expert learners. According to the authors, most of the research analyzed in the meta-analysis investigated the effects of visual feedback on beginners and no studies discussed whether experts benefit more or less from visual feedback. Thus, the present study aimed to investigate the effect of video feedback on motor learning by novice and experienced learners, characterizing different stages of learning (beginner and experienced). The hypothesis was that a ceiling effect could occur for experienced learners[12], since they have already mastered many elements of the action and, therefore, have little left to learn.

Specifically, this study investigated the effect of video feedback on learning the "hoop throw" skill by Rhythmic Gymnastics practitioners. Rhythmic Gymnastics (RG) is a competitive, exclusively female gymnastic modality that involves rhythm, flexibility, and lightness. RG comprises skill categories in five apparatus (hoop, ball, rope, ribbon, and clubs) and is a sport modality with high technical difficulty, in which a high level of performance is commonly achieved at a very young age, in a way that presupposes the need to start practicing as early as possible[18]. Thus, it is expected that the results of the present study will lead the discussion on possibilities for intervention strategies for the practice of this and other sports modalities.

METHODS

Participants

Twenty girls, Rhythmic Gymnastics (RG) practitioners, aged 10-14 years, participated in this study, all as volunteers. Parents of the children signed the informed consent form approved by the Ethics Committee of the Federal University of Ceará (n. 1.851.821). The aim of the study was explained to the children, after which they were divided into two groups with 10 participants each: Group Beginner (GB), composed of RG practitioners for a maximum of one year without interruption (11.1 ± 1.2 years old); and Group Experienced (GE), composed of RG practitioners with at least two consecutive years of practice (12.3 ± 1.0 years old). The time of RG practice to characterize each group was determined based on the fact that practitioners with a maximum of one year of practice have generalized experiences that allow them to understand and perform the experimental task, while practitioners with two or more years of practice have more stable levels of performance, as well as competitive performance [18]. During the experimental phases, four participants of the GE were frequently absent, due to competition participation, and were excluded from the sample.

Materials

All experimental phases were applied at a rhythmic gymnastics school, in a large room with a rhythmic gymnastics floor. Hoops of 60 cm and 90 cm were used, which are indicated for the category of the participants in the present study (10-14 years, pre-infant, infant, and youth categories), varying according to the height of the participant. A smartphone camera (16 mpx quality) was used to record each participant's performance. The Smartphone was positioned on the side of the rhythmic gymnastics floor, approximately 5 m from the participant, to record the lateral plane of the performance. In addition, the Smartphone was connected to a notebook (15 inch screen) to provide visual feedback to the participants. After the experimental phase, the notebook was used by RG professionals who could watch the videos of the participants' performances and attribute scores.

Experimental Task

Hoop Throw: this throw is part of the technical group of RG skills. It is used in all apparatus and is characterized as a large throw (twice the height of the gymnast) or medium throw (one to two times the height of the gymnast)[19]. In the present study, the experimental task was the hoop throw, followed by a chainée (rotation) and, then, hoop recovery with the hand.

Procedures

Participants of both groups performed the experimental task individually in four experimental phases: Pre-test (1 day), Acquisition (10 days), Post-test (1 day), and Retention (1 day). Each experimental phase occurred one week after the previous phase. The Acquisition phase occurred on Monday, Wednesday, and Friday of each week. Each phase occurred before the beginning of the participants' RG class. Table 1 shows the number of trials, the recording trial, and feedback provided in each experimental phase. In all phases, a 30 seconds rest interval was allowed between trials. In all sessions of the Acquisition phase, participants sat close the Notebook, on the side of the rhythmic gymnastics floor, to watch their performances on the video. No verbal instruction was provided to the participants during the experimental phases.

Table 1 – Experimental procedures of the study

Phase	Session	Trials per session	Trials recorded	Feedback
Pre-test	1	3	All	No
Acquisition	10	12	3rd 6th 9th 12th	After 3rd 6th 9th 12th
Post-test	1	3	All	No
Retention	1	3	All	No

Data Analysis

Two gymnastics referees of the Ceará State Gymnastics Federation evaluated the performance of participants, by watching the final recorded trial of each experimental session of each participants and rating (1-5) the hoop throw according to the following technical criteria:

i) The throw was up (right) or backward (wrong);
ii) The height of the throw (large throw);
iii) The quality of the rotation;
iv) Accuracy in hoop recovery (one hand only);
v) If there was hoop fall.

For each technical criterion, the RG professionals gave a rating of zero or 1 (one), so the maximum score for each participant could reach 5 (five). The videos were identified with numbers and presented in random order to the RG professionals so they did not have knowledge of the experimental group or the experimental phase of each video analyzed.

Data Analysis

First, the Pearson's correlation test was used to analyze the consistency of both RG professionals' evaluations. Subsequently, the final recorded trial of each participant in each experimental phase was submitted to statistical analysis. One-way analysis of variance (ANOVA) was used to compare the performance of each group between the Experimental Phases (Pre-test, Acquisition, Post-test, and Retention). Significant main effects were identified using the Bonferroni' post-hoc test. The level of significance adopted in all statistical analyzes was 0.05. The software Statistic 7.0 was used in all statistical analyzes.

RESULTS

The result of the Pearson's correlation showed considerable consistency of both RG professionals' evaluations ($r = 0.68$, $p < 0.001$). In general, the performance of GE participants (3.9 ± 0.44) was higher than the performance of GB participants (2.73 ± 0.54). The results of the performances of each group during all experimental phases are presented in Figure 1. Figure 2 describes the scores of both groups over the 10 sessions of the Acquisition Phase, however, only the scores of the final session of the Acquisition Phase were used in the statistical analysis.

For the GB, ANOVA showed significant differences in performance between the experimental phases, $F(3, 36) = 5.078$, $p < 0.01$. Specifically, the Bonferroni post-hoc test showed significant differences in the performance of the GB between Pre-test (2.0 ± 0.6) and Acquisition (3.1 ± 0.5) phases ($p = 0.01$) and between Pre-Test and Retention (3.2 ± 0.7) phases ($p = 0.01$). For the GE, ANOVA showed no significant differences in performance between the experimental phases, $F(3, 20) = 1.329$, $p = 0.29$.

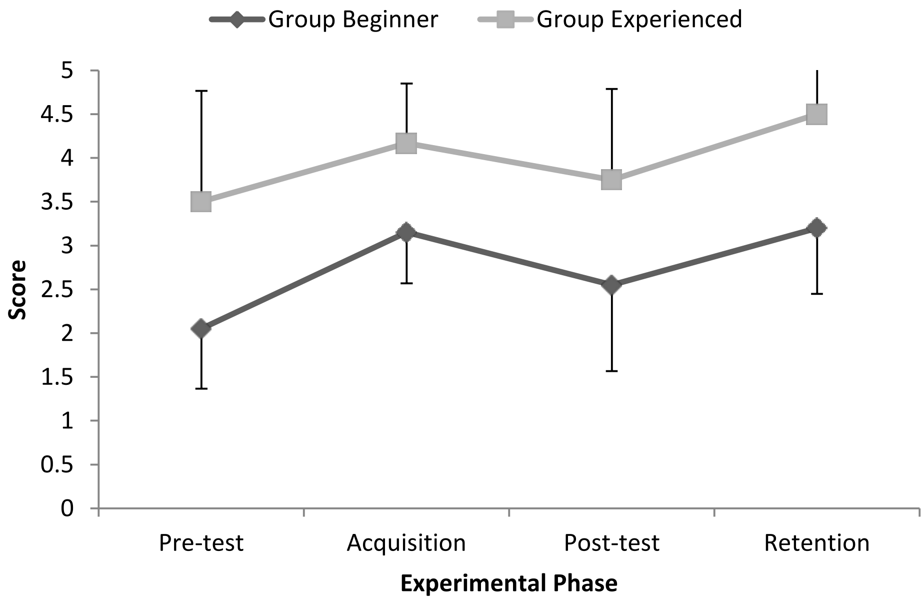

Figure 1. Mean and standard deviation of the scores of Beginner and Experienced groups in the final recorded trial of each experimental phase.

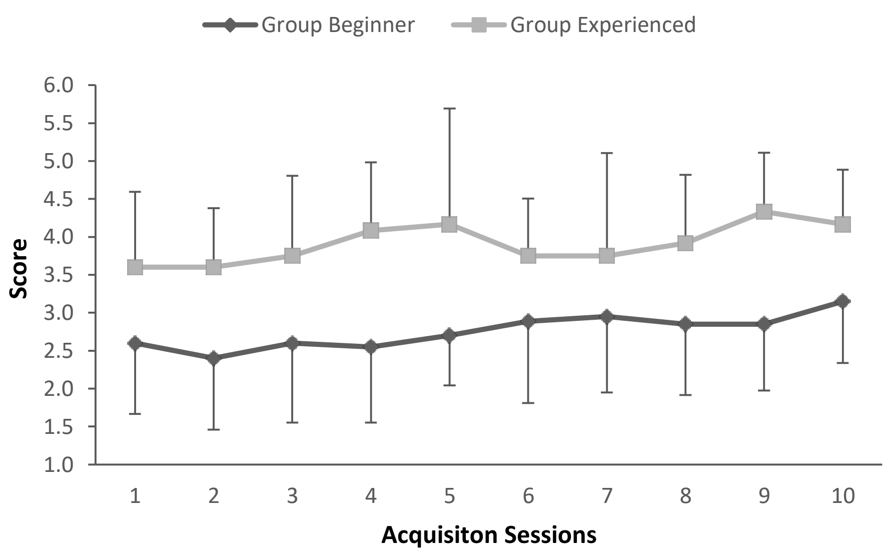

Figure 2. Mean and standard deviation of the scores of Beginner and Experienced groups in the final recorded trial of the 10 sessions of the Acquisition phase

DISCUSSION

The present study investigated the effects of video feedback on hoop throw learning in Rhythmic Gymnastics practitioners at different stages of learning. The use of video feedback has been reported in the literature as an important strategy, especially in sports, to improve performance. Although video feedback has little advantage over verbal feedback[12], the literature has pointed out that vision can detect specific aspects of movement that are not perceived during the action and are difficult to describe verbally[4, 20]. In addition, visual observation of performance can improve learners' ability to detect and correct errors[21].

The main finding of the present study is that video feedback improved performance of beginner learners, while the same effect was not observed for experienced learners. In the present study, only participants of the GB showed statistically different performances between the Pre-test and Retention phases. According to Magill[15], novice learners are not yet able to use proprioceptive information during the action to improve performance, and, therefore, often need augmented feedback. It is through practice and experience in the modality that proprioceptive information is used more efficiently in motor performance. Thus, given the low use of proprioceptive information at this early stage of learning, video feedback may help GB learners to obtain more details of the action, which they did not perceive during the execution.

In addition, this positive effect of video feedback on the learning process of GB participants leads to the discussion that they improved both motor and cognitive components of the action. According to the literature on motor learning stages, beginners are constantly trying to acquire a cognitive representation of action, do not know which elements of the action to focus on, and have concerns about coordination pattern[15, 17]. By watching the videos, participants detected errors and sought mechanisms to improve performance in following trials. Even if they could not perform the movements successfully later, they may have understood, for the most part, what needed to be done to throw, rotate, or recover the hoop correctly, developing a sense of the whole coordination pattern. In this way, it is possible that video feedback may have accelerated the process of establishing cognitive representation of action[13], since this representation is still developing during the initial stages of learning.

The results for the GE showed few changes in the participants' performance over the experimental phases. The hypothesis of a ceiling effect of video feedback for experienced learners[12] was confirmed. This may have been due to the fact that the participants of the GE already presented an automated movement in the execution of the hoop throw skill, besides which they had already attained mastery of many elements of the action and, therefore, had little left to learn. According to Schack and Mechsner[22], more experienced individuals have a more advanced cognitive representation of action. In addition, it is expected that individuals in more advanced stages of learning can recognize the error and also establish solutions for it[20]. In this way, the information presented in the video feedback may have been redundant for GE participants because they were being informed of something they already knew[23].

Although there were no significant differences between the performance of the participants in the GE in the Pre-test and in the other experimental phases, it was possible to observe some performance improvement through the experimental sessions (Figures 1 and 2). This may have occurred because the video feedback provides information on errors and correct movements of the coordination pattern, but also has the role of motivating the learners. Learners are able to observe their own performance visually[4], and, therefore, the video reinforces their own perceptions about their performance, confirming success[8].

When learners are motivated to observe their performance in the video and use this information to confirm their perceptions about their performance, they do not only learn aspects of the pattern of movement, but also learn to trust their perceptions and advance, more and more, to an autonomous stage of learning. Chiviacowsky and Wulf[24] argue that when there is confirmation, through feedback, that the performance was good, feedback may help set a pattern and reduce unnecessary changes. Often, experienced learners knew what was wrong and successful in a performance and while watching the video remarked: “I know I did this or that”. This did not happen for beginners who watched the video trying to perceive what they did in the performance. Thus, the present study suggests that video feedback for experienced learners may be redundant, but not necessarily obsolete, as it confirms their own perceptions about performance and thus may increase their autonomy in the learning process.

Although the present study advances the discussion about the effect of video feedback on motor learning by beginner and experienced learners, it is important to consider that the results found can also be derived from the practice (experimental trials and sessions) of the hoop throw skill. Independent of the type, frequency, and provision of feedback, practice is central and essential for motor learning[17]. Future studies on this topic could include a control group (which did not receive video feedback during practice) to identify specifically the effect of practice on this process.

Considering these results and those of other studies, the present study suggests that video feedback can be used by movement professionals and teachers to improve learner performance. Specifically, this study suggests that the effect of video feedback is positive for beginner and experienced learners, but different for each of them. Thus, it is up to the teacher/professional to know the characteristics of each stage of learning of the skill and to use visual feedback for specific purposes in each of these stages. In addition, we believe that new technologies available to society in general, such as Smartphones and Tablets, aid in the recording and replaying of video performances and serve as tools for providing instantaneous video feedback.

Until the present moment, little has been discussed about the role of video feedback on motor learning by experienced individuals. Ericsson, Côté and Fraser-Thomas[25] argue that there is a lack of access to this population. This aspect was evident in the present study, considering that four participants of the GE missed some experimental sessions due to their participation in RG championships. Thus, the present study advances the discussion about the use of video feedback during practice by individuals in different stages of motor learning and suggests that, even if the advantages of using video feedback are small, such as those observed in the performance of the GE, they may be important to individuals interested in improving even a little.

Despite these advances, the present study presented some methodological limitations such as those associated with sample size, participants missing sessions, and variables analyzed. The sample was small due to difficulties in finding rhythmic gymnastics practitioners in the city. In addition, some of the experienced practitioners participated in RG championships, in which they represented the city and the state, and therefore could not participate in all the experimental phases. Despite the consistency between the RG professionals’ evaluations, kinematic measures could have substantiated the changes in participant performance throughout the experimental phases and been more coherent in the evaluation of the process of coordination pattern acquisition. Furthermore, as previously suggested, another limitation of the present study was that it did not include a control group. This fact occurred due to difficulties in finding participants of similar ages and with similar RG practice time of as the sample.

CONCLUSION

The present study suggests that video feedback is an effective tool for the motor learning of apparatus manipulative skills of Rhythm Gymnastics. In addition, it is concluded that the effect of the use of video feedback is more evident in the motor learning process of individuals in the initial stages of learning. The present study has advanced the discussion about the effect of video feedback on motor learning by experienced individuals and suggests that, even though performance improvements may be small at this stage, video feedback can confirm learners' perceptions and thus help them to advance to more autonomous stages of the motor learning process.

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