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Knowledge of visual and verbal performance in learning a judo throw: *tai otoshi*

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A Study Design
B Data Collection
C Statistical Analysis
D Manuscript Preparation
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Abstract

Background & Study Aim: Learning motor skills is a complex process, influenced by different factors, including extrinsic feedback. Knowledge of performance (KP), a type of feedback, provides information to the learner in the process of acquiring motor skills, as it is related to the movement pattern. The present study aim is knowledge about the effects of different forms of KP supply (visual, verbal and visual + verbal) on learning a judo throw: tai otoshi.

Material & Methods: Thirty-six participants were randomly assigned to three groups: visual KP group (VIKPG) the learners received KP through video; verbal KP group (VEKPG) the learners received KP verbally from a single experimenter, with a description of the sequence of the skill elements; visual + verbal KP group (VIVEKPG) the learners received KP through video and KP through the experimenter, alternately. The experiment consisted of a pre-test, acquisition phase, post-test and retention test.

Results: The results of the present study determined a significant difference between the groups, with superior performance of VIVEKPG in relation to VEKPG or VIKPG. These findings suggest the positive influence of the two forms of information in the analysis and correction of the movement structure, leading to more effective motor learning.

Conclusions: In short, the visual KP associated with the verbal KP promoted a better learning of the judo throw: tai otoshi. This finding seems to be associated with the complementary aspect of the two forms of information in the process of acquiring motor skills.

Keywords: acquisition • extrinsic feedback • intrinsic feedback • motor learning • motor skill

Conflict of interest: Authors have declared that no competing interest exists

Ethical approval: The study was approved by the Research Ethics Committee of the Federal University of Minas Gerais, Brazil (Resolution 466 of the National Health Council, 2012)

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Acquisition – *noun* the development of a new skill, practice or way of doing things [34].

Knowledge of performance (KP) – augmented feedback that provides information about the quality of the movement (e.g. rhythmic, smooth, mechanically efficient, beautiful, etc.) [35].

Motor – *adjective* relating to muscle activity, especially voluntary muscle activity, and the consequent body movements [34].

Motor skill learning – *noun* the acquisition of new motor skills, either as a child or as part of sports training [34].

Performance – *noun* the level at which a player or athlete is carrying out their activity, either in relation to others or in relation to personal goals or standards [34].

Technique – *noun* a way of performing an action [34].

Feedback – *noun* comments in the form of opinions about and reactions to something such as athletic performance, intended to provide useful information for future development [34].

Bandwidth feedback – feedback provided only when errors a certain tolerance level [35].

Intrinsic feedback – sensory information that occurs normally when performers produce movements; it can come from sources outside the body (exteroception) or inside the body (proprioception) [35].

Extrinsic feedback – sensory information provided by an outside source in addition to that which normally occurs when performers produce their movements (i.e. intrinsic feedback); sometimes referred to as augmented feedback [35].

Tori/uke – the person who applies a technique in jūdō training. The receiver of the technique is referred to as uke [36]; to facilitate perception, both names are written in capital letters: ***Tori*** who applies the action; ***Uke*** the person on whom the action in being applied.

INTRODUCTION

In 1882, Jigoro Kano, a young Japanese university graduate founded judo [1], a martial art that became extremely popular; being practiced in more than 200 countries around the world [2], making it an official Olympic and Paralympic sport, represented by three fundamental principles: physical education; proficiency contest and mental training [1] and by three domains: competitive matches, technique, and self-defence [3].

Currently, Physical Education professionals operate in the following segments of judo: organic and functional preparation (physical preparation); technical and tactical orientation; and organization and management of the different modalities [4]. However, judo specifically still has very little applied research done from the point of view of a professional's intervention. Studies on motor skill learning and the effects of consolidating these skills can be linked to the aspects associated with the acquisition of a new complex task with specific demands in combat sports modalities [5, p. 144].

In real-life situations, primarily in the acquisition of sports skills, using feedback as the information 'concerning successful and incorrect aspects of movements already executed' is an essential influencing factor [6]. When this information is not acquired by the student himself, but is instead given through feedback from external sources, it is of an extrinsic nature, being then transmitted through the different tasks for motor skill learning, which have different objectives and a varying amount of information given about what is to be learned [7].

The ability to recognize patterns of corresponding movements and the structural characteristics of the movement in the initial stages of learning, which indicates what will be done, has proven to be a fundamental variable in combat sports such as judo [5]. In this way, knowledge of performance (KP) is fundamental to the student or athlete [8].

Therefore, KP is understood as extrinsic information, kinetic or kinematics, a post response to some aspect of the movement pattern [9]. Among the possibilities for experimental manipulation of the KP which influence the acquisition of motor skills, and which refer to the nature of the movement, the pattern of movement is produced with the aid of visual and verbal KP [10].

The visual KP is characterized by showing the learner his own demonstration of the motor skill performed, thus allowing him to elaborate and implement self-correction, contributing to the achievement of the desired result. On the contrary, the verbal KP is characterized by transmitting any communicative concept in teaching-learning situations during the consolidation of motor skills [10].

In this way, providing KP about errors and ways to correct them is an effective approach, particularly when teaching motor skills to beginners [11]. However, in the consolidation of complex motor skills, it is necessary to identify the key information and provide them during the skill acquisition process [12]. Such information is particularly important during the initial stages of learning, when the learners are incapable of interpreting the properties of their movements [13].

Conceptualizing for a learning paradigm of a motor skill in a real teaching-learning context, learning a new sports skill involves the development of coordination and control of one's limbs and body movements [14], consisting in integrating various motor skills with the aim of achieving an identified goal. In this way, the number of 'pieces' of information needed to correct a sports skill would be directly related to the number of body segments used to acquire the motor skill [5]. That way, providing visual KP with verbal KP is of fundamental importance for the learner, as he does not have the ability to interpret changes in motor skills that cause improvements in learning levels.

The present study aim is knowledge about the effects of different forms of KP supply (visual, verbal and visual + verbal) on learning a judo throw: *tai otoshi*.

MATERIAL AND METHODS

Sample

Thirty-six volunteers aged 18 to 35 years old of both sexes participated, 18 men and 18 women (mean age 23.11 ±4.57 years). All declared themselves to be right-handed and inexperienced in the task and practice of judo.

Ethical Care

The study was submitted to and approved by the Research Ethics Committee of the Federal University of Minas Gerais (Brazil). All procedures used in this study met the standards established by Resolution 466 of the National Health Council (2012) on scientific research involving human beings.

The volunteers were considered participants in the research only after signing the Informed Consent Form containing information about the procedures as well as the risks and benefits associated with participating in the research. All participants were informed that they could give up their participation in the study at any time, without the need for justification. The volunteers were informed by the researcher about the objectives and methodological procedures of the study. The volunteers were informed about possible risks and discomforts, as well as the benefits related to the participation in the experiments and compensation for possible damages. They were also informed that if any of the phases of the study were missed, they would be excluded from the study.

Task

The task used in the present experiment was the judo throw: *tai otoshi* (JTTO) [15], which translates from Japanese as 'body drop', 'tai' meaning body and 'otoshi' meaning drop; this judo throw is classified as a *te-waza*, arm technique. A technique to pull down and throw the opponent by breaking his balance forward and turning the body to the left to put the right foot in front of his right foot [14].

The judo techniques are divided into three phases, the sequence of which must be respected: 1) *kuzushi* (imbalance), *Tori* (who applies the action) uses force in the most efficient way, it is fundamental to take *Uke's* balance (who receives the action); 2) *tsukuri* (fitting or approach), *Tori* to perform a throw after unbalancing *Uke*, moves his body, putting him in position for the throw; 3) *kake* (throwing the opponent), in which, taking advantage of the result of the previous position, he throws *Uke* (Figure 1) [16].

The JTTO, according to the two-dimensional taxonomy of motor skills, can be classified as: transporting the body and manipulating the object, that is, the *Uke* [15]. According to the one-dimensional taxonomy, it can be classified as: series, that is, discrete movements performed in sequence [17], *kuzushi*, *tsukuri* and *kake* [16].

In JTTO the number of components, and the interaction between these components defines the level of complexity of the throw [18]. Thus, the JTTO is characterized by a higher percentage of interaction between its components, representing the specific and dynamic character of the throw [18]. In it, there is no other contact with *Uke* except the hands, and to enhance the throwing action, the energy accumulated with the joint action of segments, for example, *Tori's* rotation, is transferred to the arms that will perform the throwing action [18].

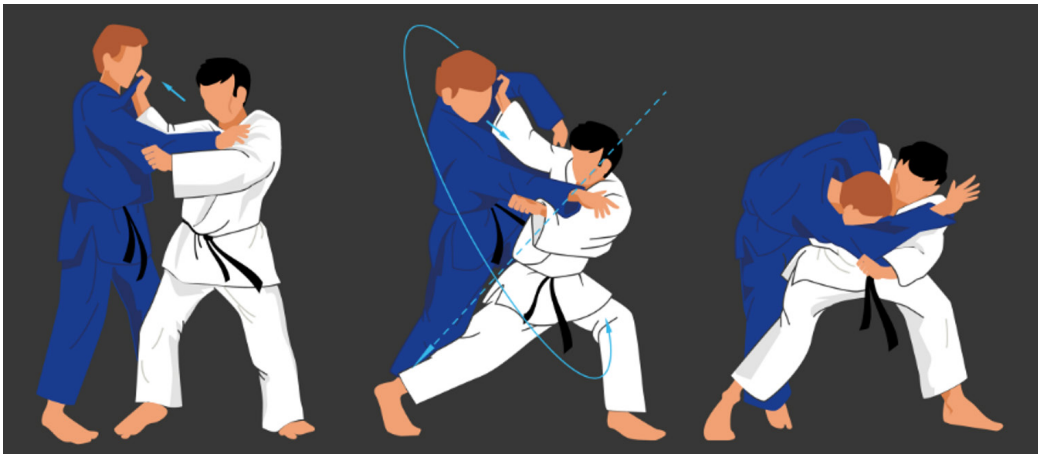

Figure 1. Illustration of the phases of the judo throw: *tai otoshi.*

Instrument

The instrument used was the checklist (CHKL) to evaluate the JTTO. This instrument sought to clearly and pertinently assess the applicability of the selected sporting skill, considering the CHKL validation of the JTTO (Table 1) [19].

In the assessment of motor behaviour, the quality of movement patterns is commonly assessed using a checklist, which aims to quantify specific items of the movement performed. Thus, it can be concluded that the CHKL for the JTTO was designed to provide detailed observations of the movement pattern presents a representative content and proves to be reliable [19].

In order to evaluate the learning of the overall configuration of the throw in *tai otoshi*, the evaluation criterion was established by analysing the main points of the phases of the throw: a) *kuzushi* – imbalance; b) *tsukuri* – the fitting or approach. Each phase was evaluated in the following way of scoring: (1) bad; (2) regular; (3) good; (4) very good.

Experiment design

Participants were randomly divided into three groups: Visual KP Group (VIKPG) the learner received KP through video; Verbal KP Group (VEKPG) the learner received KP verbally from a single researcher, with a description of the sequence of skill elements (Table 2); Visual + Verbal KP group (VIVEKPG) the learner received KP through video and KP through the researcher, alternatively. The visual KP was provided through video of the apprentice's own execution. Verbal KP followed the order of the checklist for each item.

To ensure that all research subjects began the study at the same learning level, based on the CHKL of the general JTTO configuration, a pre-test was performed.

The study consisted of four phases: pre-test, acquisition phase, post-test and retention test, which featured the execution of the same task performed in all phases, but with changes in the number of sets and number of attempts [20].

Table 1. *Tai otoshi* "Global Throw Configuration" evaluation protocol (source [19]).

Rating	***Kuzushi* (imbalance)**	***Tsukuri* (fitting or approach)**
(1) bad	There is no twist that characterizes tai otoshi's kuzushi, or Tori has moved to Uke, so that the distance between the Uke and Tori has become small, so Uke's body does not lean forward. There is no pulling movement of the sleeve by Tori.	Tori does not perform a 180º turn. It probably won't happen unless Uke projects.
(2) regular	Tori performs the turn to displace Uke, the hand Tori uses to hold on to the sleeve is located below an imaginary horizontal line below the chest for the entire duration of the turn. Uke's torso is straight, and both feet are resting on the ground, to compensate for Uke's state of balance, the harai goshi throw can occur. 2b. REGULAR: The Tori performs the arm movement after the moment of the lever, changing the order of the components.	Tori performs the rotation very close to Uke, so that the Uke's leg and hip will hinder the projection, and as the Uke is very close, the Tori can occasionally perform the harai goshi throw.
(3) good	The Tori performs the spin, and his hand remains below an imaginary horizontal line. The hand may be located on the Tori's own abdomen, but the Uke's torso is tilted forward, and the Uke may even be supported with the tip of his right foot. The correct time for the Uke to tilt is when Tori is approaching his right leg during the spin.	Uke is positioned behind Tori's back, projecting Uke over his hip. In tai otoshi Uke is projected over the leg.
(4) very good	Tori performs the spin, and the hand that holds the Uke's sleeve is detached from his body at the chest line. The Uke should be supported only on the tip of the right foot. Tori's sleeve lowers only when the Uke is crossing over the Tori's right leg.	The Uke is projected over the Tori's right leg, and there is a distance between the Uke's and the Tori's right legs.

Data were organized in sets of ten attempts, being one set in the pre-test, nine sets in the acquisition phase, one set in the post-test and one set in the retention test. All attempts were recorded by two cameras, one camera in the frontal plane and one in the left sagittal plane at a 45-degree angle. In the pre-test, the subjects watched a video containing verbal instruction and a demonstration of how to perform the task, then performed a set with ten attempts. The sequence description of the three skill elements was as follows:

The CHKL was elaborated with the right *kumi-kata* (grip), so if the throw to be evaluated is with the left grip, the right and left sides in the list must be inverted.

The acquisition phase was performed on three subsequent days with an interval of 24 hours. Before the practice, the participants watched a video containing verbal instructions and a demonstration of how to perform the task. On each day, the subjects performed three sets (three sets of ten attempts) totalling 90 attempts in which the KP was provided according to the group. Subjects received visual KP through video footage of their own execution. The verbal KP followed the order of the checklist for each item, *kuzushi*, *tsukuri* and *kake* (highlighting the main points of the throw).

The post-test was performed ten minutes after the acquisition phase to determine the level of performance after the practice period. This post-test consisted of a set of ten attempts (without prior information and without providing KP).

One week after the acquisition phase and the post-test, the retention test was performed in which the subjects performed the same post-test procedure (a set with ten attempts, without prior information and without providing KP), to determine performance level and motor skill retention.

Experimental Procedure

The data collection was performed in the *dojo* (a room suitable for the practice of judo) at the School of Physical Education, Physiotherapy and Occupational Therapy at the Federal University of Minas Gerais (Brazil).

Initially, a meeting was held with the volunteers and the team, to provide information about the procedures that were adopted during the research. Subsequently, the terms of consent and free clarification were delivered.

Data collection was performed individually in a suitable room, with controlled temperature, noise level and luminosity. The subjects initially received verbal instruction together with a demonstration about the description of the sequence of the skill elements through a video by a judo expert, where the execution of the ideal JTTO pattern was visualized (Table 2).

The apprentices were filmed in all attempts performing the task that was used in this experiment, the JTTO, and after each set of ten attempts, the apprentices received the KP corresponding to each group. The KP was provided within five seconds from the end of each trial set.

Table 2. Description of the sequence of the three elements of the skill (source [19]).

Description of the sequence of the three elements of the skill
A) Tori advances his right leg in front of Uke's right leg and simultaneously unbalances Uke forward and diagonally to the right which will leave Uke supported only by his right foot.
B) Tori, after spinning (180), supports his left leg in front of Uke's left leg and supports his right forearm on the Uke's chest.
C) Tori supports his right leg in front of Uke's right leg and projects Uke over Tori's right leg.

The score achieved by the participants was marked, according to the assessor's grades and the results of the agreement test among the participants. For greater robustness of the method, the assessors, when watching the videos, did not know which group the 'simple veil' apprentices belonged to. For the JTTO evaluation, three judo experts used the CHKL for the JTTO on the points to be evaluated. All three assessors (specialists) are trained in Physical Education, black belts above the third degree, with more than twenty years of teaching experience, experience in refereeing at the national and international level, and registered by the Brazilian Judo Confederation (CBJ).

Measures

The movement pattern was the dependent variable used. The evaluation criteria focused on the most relevant aspects of the movement execution for the performance of the skill: *tai otoshi* 'Global throw Configuration' evaluation protocol. Based on these criteria, we sought to determine whether or not there was a qualitative improvement in movement production, comparing the subjects' movements in the execution of the JTTO during the pre-test, post-test and retention test, constituting this procedure a measure that allows evaluating the subjects' performance in skills for which the correct production of movement is the objective of the action.

For the evaluation of the JTTO, three judo experts used the CHKL of the JTTO [19]. An ordinal scale from one to four was used. One representing a bad execution of the action, two regular, three good and four representing a very good, perfect (optimal) execution of the action, to quantify the proficiency of the JTTO in the CHKL of the global configuration.

The analysis of the throws was performed by the evaluators through the participants' videos, twice, with an interval of one week between the evaluations, according to the criteria established in the evaluation form [19]. The scores of the groups were organized, first in relation to the score (pre-test, acquisition phase, post-test and retention test) and then according to the score obtained in the components (interclass agreement).

To assess the intra-ratter reliability, the images were evaluated on a given day and one week later they were re-evaluated.

Statistical analysis

For data analysis, a descriptive analysis mean and standard deviation (±) was performed within subjects in sets of 10 trials. In phases: pre-test, acquisition phase, post-test and retention test. Data normality analysis using the Shapiro-Wilk test, as well as the analysis of its homogeneity using the Levene test. Once these criteria were met, a Two-Way ANOVA (Groups and Tests) with repeated measures was used for intra – and inter-group analysis. As Post Hoc, the Tukey test was used to identify the differences. The significance level adopted was $p<0.05$.

The data were organized in mean and standard deviation of the score in sets of ten attempts, thus originating a set in the pre-test, nine sets in the acquisition phase, a set in the post-test and a set in the retention test (Figure 2).

RESULTS

The results of the analysis of variance did not indicate differences between ratters $F(2, 33) = 0.16$, $p = 0.9$ and also did not indicate differences regarding the intra-ratter evaluation $F(1, 33) = 0.54$, $p = 0.46$.

The results showed a significant difference between the groups and when analysing the behaviour of the groups over time, it was found that there was a significant interaction ($F = 3.66$, $p = 0.009$). The results indicated for GROUPS $F(2, 33) = 3.497$, $p = 0.042$ and TESTS $F(2, 66) = 225.68$, $p = 0.001$ and for TESTS GROUPS $F(4, 66) = 3.6639$, $p = 0.001$.

The means reached in the pre-test that determined the groups were: VIKPG =1.24 ±0.42; VEKPG =1.24 ±0.49 and VIVEKPG=1.44 ±0.43. When analysing the pre-test in the intra-group test, the result was that the three groups started the practice of the task in a similar way in relation to the presented score $F(2, 47) = 0.521$, $p = 0.597$. This ensured that the groups started the experiment with the same level of task performance. There was a statistical difference between pre-test and post-test ($p = 0.0001$) and retention test ($p = 0.001$).

In the pre-test, the groups were statistically equal to each other: VIKPG x VEKPG ($p = 0.99$); VIKPG x VIVEKPG ($p = 0.99$) and VEKPG x VIVEKPG ($p = 0.83$). In the post-test, VEKPG was equal

to VIVEKPG (p = 0.99), and both were superior to the visual group. Regarding the retention test (learning), through Tukey's Post hoc, the VIVEKPG performed better than the other groups (p = 0.0001) and there was no difference between the VIKPG and VEKPG (p = 0.98).

There was an improvement in the three groups after the practice period (acquisition phase). When comparing the performance of the post-test groups for the retention test (performed within one week) it is possible to observe that: The VIKPG maintained its performance between the post-test and the retention test, however, with lower quality than the VIVEKPG; The VEKPG had a decrease in performance and there was no statistical difference with the VIKPG (p = 0.98). It can also be seen that VIVEKPG maintained its performance in relation to the post-test and was superior to VIKPG and VEKPG (p = 0.0001) (Figure 2).

DISCUSSION

It can be said accordingly among ML researchers that practice and extrinsic feedback are essential factors for learning motor skills. Despite this, the effects of these factors provided together or in isolation have been little investigated and divergent.

Due to the characteristics of the learning task and the type of extrinsic feedback used, called KP. As the learning process in judo involves the acquisition of skills not familiar to the individual's daily life, the use of auxiliary means such as instruction and verbal cues are important to help the teaching-learning process [21]. The intention was to emphasize the validity of the task learning methodology (specifically, the form of KP provided) so that the results can be transported and applied to the professional practice situation more easily. From the point of view of some studies, when two components interact with each other, the resulting behaviour is different from the individual behaviour of the components [22].

The first explanatory hypothesis (H1) that the performance and learning of the JTTO would be more effective for the groups that received visual KP when tested. However, the results of the present study do not confirm this hypothesis. The results showed an improvement in the VIKPG performance between the pre-test and the post-test, maintenance of the performance level between the post-test and retention test, and it is not possible to assume that the VIKPG is better than the VEKPG and VIVEKPG groups, because in the retention test (learning) the VIKPG had similar performance to the VEKPG and inferior to the VIVEKPG.

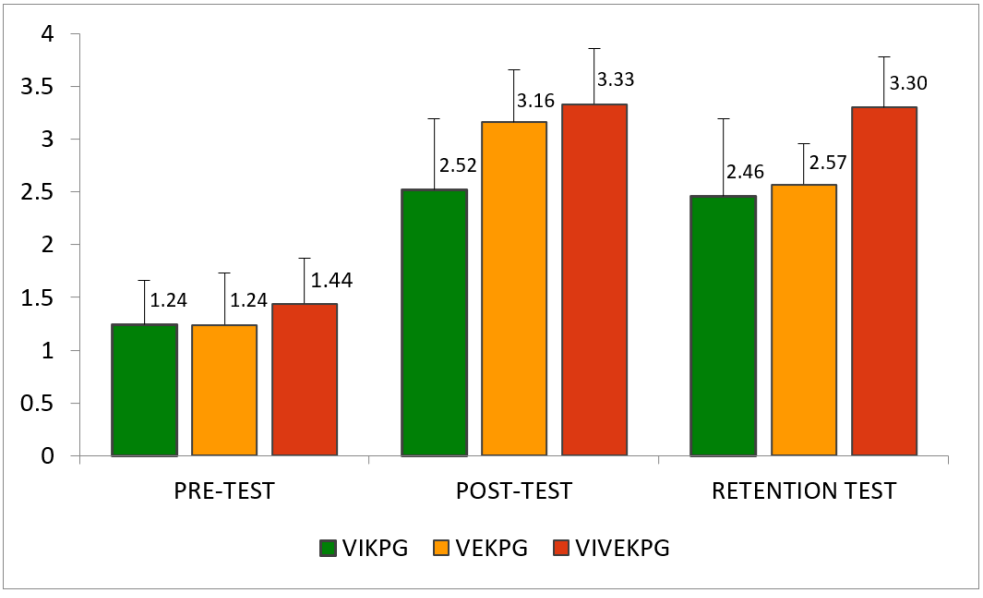

Figure 2. Mean score achieved and standard deviation of the groups: visual, verbal and visual + verbal in the pre-test, post-test and retention test.

Although some studies have found positive results in the use of visual KP [23-25], normally the use of visual KP in the early stages of learning is not successful, because although individuals are aware that they are doing something wrong, they are generally unable to detect the origin or characteristics of the error committed [17]. In relation to this aspect, studies show that during the interval between the post-test and the retention test, in a prolonged period as in the configuration of this study (one week), the loss of information in the visual working memory is promoted [26]. Regarding ML, to be more efficient, visual KP must be associated with verbal instruction, verbal KP. The authors state that demonstration combined with verbal instruction results in superior performance in the transfer of new skills [27].

Regarding the results of the second explanatory hypothesis of the study (H2), that the verbal KP group would be better compared to the visual KP and visual and verbal KP groups. This hypothesis has not been confirmed either. The results showed an improvement in the performance of the VEKPG between the pre-test and the post-test, a drop in the level of performance between the post-test and retention test, and it is not possible to assume that the VEKPG is better than the VIKPG and VIVEKPG groups, because in the retention test (learning) the VEKPG had similar performance to the VIKPG and inferior to the VIVEKPG. This condition may have occurred because of the time interval between the post-test and the retention test, which happened after a week, since verbal information is related to short-term memory.

To characterize the lasting effects of learning a task, it is necessary to wait a defined time to understand how forgetting the task intervenes. This type of analysis requires the existence of a known time interval technically defined as 'retention interval', which in the case of this study took place within a week. However, studies show that working memory is a short-term storage system, with limited capacity, which allows the conservation and manipulation of information necessary to perform complex tasks that involve understanding, learning and reasoning [28-30].

Feedback studies have primarily verified the effects of feedback on the immediate performance of a task, not considering its influence on aspects of learning retention, but also omitting to analyse tasks in real practice conditions [31].

Finally, the results confirmed the third explanatory hypothesis [H3] of the study, concerning the condition that the group that received the two pieces of information, visual KP and verbal KP, would present a superior performance in the tests (post-test and retention test) when compared to the groups that received the information, when taken separately, related to visual KP or verbal KP. This hypothesis has been confirmed. The results showed an improvement in the VIVEKPG performance between the pre-test and the post-test, maintenance of the performance level between the post-test and retention test, and it is possible to assume that the VIVEKPG was better than the VIKPG and VEKPG groups, as in the post-test VIVEKPG had a performance similar to VEKPG and superior to VIKPG and in the retention test (learning) VIVEKPG had a superior performance in the two groups: VIKPG and VEKPG.

These findings are in agreement with the results of studies in the literature [11, 5] that demonstrated the superiority of the groups receiving both types of KP combined. Verbal cues and demonstration through videos, verbal and visual KP, can be used in a combined way and presented more effective results in performance than in situations where individuals received only verbal feedback [32].

These conclusions and the studies cited in the literature reinforce the theory of the results of this study presented, suggesting that in the acquisition of complex sports motor skills such as judo throw, it is essential to provide the learner with both types of information, visual KP and verbal KP, whether combined and/or alternatively. It is necessary to develop further studies on the aspects mentioned in this study in order to better understand which information stimuli are more suitable for an effective acquisition of complex motor skills such as judo throw. Even though judo is a popular and widespread fighting sport, there is a lack in literature of studies that investigate the use of these strategies in beginner judokas in the learning phase [21].

CONCLUSIONS

The qualitative evaluation showed that the KP is essential for the subjects to change the characteristic of the movement, because without external information, mainly through the verbal KP, the subjects cannot detect their errors, presenting limitations in the attempt to execute a correct

movement pattern. These were evaluated based on the improvement in the application of the JTTO through the analysis of the execution of the movement, which reflects the process measures, allowing the observation of the performance on the quality of movement production, through the evaluation of the recorded images of the subjects during the execution of the throw.

Based on the results of the present study, it can be concluded that KP is an important factor for the acquisition of motor sport skills and that when considering the task used, the best way to provide KP for the acquisition of JTTO motor skill in judo is through a combination of visual and verbal KP, resulting in a more effective learning than when KP is provided alone.

Considering this study and the literature on the subject, the traditional ideas about visual and/or verbal KP should be revised, as there is difficulty in generalizing the results and directing the application of KP in motor learning, as the studies carried out used various methods and present many variables that can still be analysed.

Finally, it is necessary to point out that, although judo is a combat sports modality that has won in the Olympics and brought innovative aspects to the teaching of fights, there are not many studies on the teaching-learning process of judo techniques [33]. Thus, using the knowledge of motor learning and the use of KP, other problems and challenges encountered in the acquisition of motor skills can be explored.

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