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Effects of the bandwidth knowledge of performance in the acquisition of a judo motor skill

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C Statistical Analysis
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Abstract

Background & Study Aim: The literature on motor learning characterizes feedback as a critical component of learning, making it an important factor in the process of motor skills acquisition. The aim of the present study was to verify the effects of the bandwidth in the acquisition of a judo motor skill.

Material & Methods: Thirty-six volunteers were randomly assigned to three experimental groups: control group (CG) that received knowledge of performance (KP) in all trials; that received (KP) in a wide bandwidth (WBG); that received KP in a narrow bandwidth (NBG). The task used in this experiment was the o soto gari throw. The experiment consisted of an entrance test, acquisition phase, post-test and retention test.

Results: The athletes from CG presented worse results when compared to the other bandwidths groups. Also, the wide bandwidth helped in the changes of performance and pattern of the movement, favouring the improvement of the consistency and precision. The wide bandwidth of KP aided in learning complex motor skills, and that the narrow bandwidth, despite helping to change the pattern of execution, was not enough to result in changes in performance. The wide bandwidth of KP was more adequate for sports learning.

Conclusion: Taken together these findings showed that the combination of a lower frequency of KP supply, the effect of qualitative information on performance, coupled with an optimal intertrial interval, was the key to the effects of the bandwidth of KP on the acquisition of a complex task with specific demands like the judo throw: o soto gari.

Keywords: bandwidth feedback • combat sports modalities • martial arts • motor learning

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INTRODUCTION

Acquisition – *noun* the development of a new skill, practice or way of doing things [42].

Knowledge of performance (KP) – augmented feedback that provides information about the quality of the movement(e.g. rhythmic, smooth, mechanically efficient, beautiful, etc.) [43].

Motor – *adjective* relating to muscle activity, especially voluntary muscle activity, and the consequent body movements [42].

Motor skill learning – *noun* the acquisition of new motor skills, either as a child or as part of sports training [42].

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 [42].

Technique – *noun* a way of performing an action [42].

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 [42].

Bandwidth feedback – feedback provided only when errors a certain tolerance level [43].

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) [43].

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 [43].

Ippon – one point. Achieved through the execution of a valid technique on the opponent [44].

Waza-ari – a *judo* term for a technique that cannot be regarded as a full ***ippon***, but is very close [44].

The literature on motor learning characterizes feedback as a critical component of learning [1], making it an important factor in the process of motor skills acquisition [2]. The feedback provides the learner with information needed to improve the detection and correction of errors [3], which is fundamental for the consolidation of the movement pattern [4], responsible for the performance of skilful movements performed in different situations, such as the sport [5], that is, the execution of movements that allow to reach an objective in the environment with maximum certainty and minimum time and energy expenditure [6], a remarkable characteristic especially in combat sports.

In real teaching-learning situations, especially in the acquisition of sporting skills, such as in martial arts and combat sports modalities (jiu-jitsu, capoeira, karate, taekwondo and judo), which require the learner's combined and successive movements, executed in all directions at high speed [7], where the result of the action depends on an appropriate pattern of motion requiring multiple degrees of freedom, that is, all independent components of a control system and the number of forms each component can act [8], knowledge of performance (KP) is fundamental to the student or athlete [9].

This ability to recognize movement patterns in the early stages of their learning [10], which indicates what will be done, when the learners are unable to interpret the properties of their movements [11, 12], has been demonstrated as a fundamental variable in combat sports such as judo [13], in this way, it can be seen as a fundamental information, corresponding to the structural characteristics of the movement [14-16], which aims to improve the quality of performance and the consistency of these skills [17].

Among the possibilities of experimental manipulation of the KP that investigate the effects of this variable in the process of motor skills acquisition, specifically in the acquisition of sports skills close to the real world [18], as in the judo throw: *o soto gari*, the bandwidth feedback is a method of supplying KP that is directly related to the learner's performance [2]. In this arrangement feedback is provided if the performance of the individual extrapolates a previously determined error range, so when performance is within range, no feedback is provided, indicating that the task goal has been achieved [19]. The bandwidth is distinguished from other forms of feedback manipulation because of the learner's performance determining the moment he will receive the information being the performance of the individual determinant for his supply, differing significantly from the forms that the information is arbitrarily provided by the experimenter, teacher or technical [20].

A number of studies have consistently demonstrated that the effects of the bandwidth feedback are increased when a relatively large range of error tolerance or wide range is used in comparison with a relatively small tolerance range or narrow range [4]. The explanations for these beneficial effects of the bandwidth of feedback have been based on the guidance hypothesis [6].

According to the guidance hypothesis, the reduction of feedback would lead to greater intrinsic processing favouring the development of mechanisms related to the detection and correction of errors, reducing the need and dependence of extrinsic information, favouring performance, guiding the learner to the goal of the task [6]. This benefit in performance is the result of a greater range of error tolerance, providing positive effects that guide the student to the correct response in learning motor skills [11].

Considering that the effect of the different bandwidths directly affects the consolidation of a sports skill, it is necessary to have a group that receives feedback in a narrow bandwidth error, called narrow range and a group that receives feedback in a wide bandwidth error, denominated wide range, allowing the evaluation of the effects of different ranges of knowledge of performance in the learning of a sporting ability, like the judo throw: *o soto gari*.

The aim of the present study is verify the effects of the bandwidth feedback in the acquisition of a judo motor skill. The hypothesis of the study will be that there will be difference between how different bandwidths of knowledge of performance in the acquisition of a judo motor skill. It is expected that a wide bandwidth over a performance of the skill facilitates an acquisition of motor skills; a narrow bandwidth over a performance of skill makes it difficult to acquire motor skills in comparison to the wide bandwidth condition.

MATERIAL AND METHODS

Ethical Cares

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

Volunteers were considered participants of the research only after they signed the Free and Informed Consent Form containing information about the procedures, risks and benefits associated with participation in the research. In addition, all participants were clarified that they could relinquish their participation in the study at any time, without the need to justify the researcher. The volunteers were informed by the researchers about the objectives and methodological procedures of the study. Volunteers were also informed of potential risks and discomforts as well as potential benefits related to participation in the experiments and possible treatment and compensation for consequential damages.

Sample

36 volunteers of both sexes participated in this experiment, 26 men and 10 women, ranging in age from 18 to 35 years (M = 28.1, ±6.7), all declared themselves to be right-handed and inexperienced in the task. If the subject did not return at any stage of the study, it would be excluded from the sample

Task

The task that will be used in this experiment was the judo throw: *o soto gari*. In short, learning the judo throw: *o soto gari* involves a goal-directed apprentice, so the apprentice unbalances the other guy with his hands, "sweeping" the supporting leg, thus causing that individual fall back [21], the judo throw is divided into three phases (Figure 1): *kuzushi* (imbalance); *tsukuri* (fitting or approach); *kake* (opponent's projection) [22].

The studies published in Japanese dating mainly from the 1970s to the 1990s, have been actively focused on the fundamental techniques of sport [23]. However, because of the technical limitations during this period, this research was mainly directed to investigate factors such as static / dynamic balance during the preparation phase (*tsukuri*) of the projection techniques [24].

Currently, judo throws have been widely used in motor behaviour studies [25], which aim to study the process of motor skills acquisition, specifically changes in movement patterns [26], one of the ways to investigate behavioural changes in the movement pattern of these skills is known as checklist (CHKL).

Instrument

An objective way of measuring performance, especially in the context of scientific research, is through a checklist (CHKL), a systematic observational tool. In this study the instrument used was the CHKL evaluation of the judo throw: *o soto gari* (Table 1). This instrument sought to evaluate with clarity and pertinence the selected

Yuko – a score in judo competition (in past).

Tori/uke – the person who applies a technique in jūdō training. The receiver of the technique is referred to as uke [44].

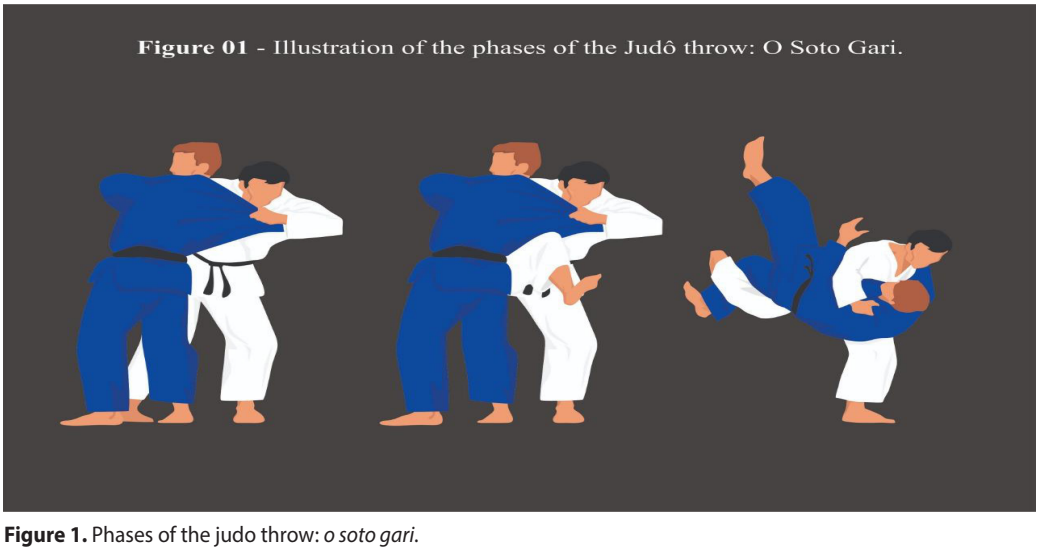

Figure 1. Phases of the judo throw: *o soto gari*.

Table 1. Evaluation protocol of the judo throw *o soto gari* – evaluation of *kuzushi* (imbalance) – evaluation of *tsukuri* (fit or approach).

Point rated	Kuzushi (imbalance)	Tsuskuri (fitting or approach)
1) bad	There is no imbalance, uke is in shizen hontai (front natural position), and body weight is distributed on both legs.	Does not perform the approach and docking. Tori does not come out of his stance, and runs the blow only with the arm.
2) regular	Note some imbalance in the sleeve, around 45° abduction of the arm relative to the body. But the weight is still distributed on both legs, as shown in the figure.	No approach of the leg, mainly because of tori's arm is hyper-extended. The consequence is to support the foot on the ground between the legs of uke.
3. I) good	The sleeve is 90° abduction in relation to the arm and the body begins to appear some collar "work", and his weight is beginning to predominate on one leg.	Moving the supporting leg, the left one. Occurs some approximation, tori "kicks" the free leg forward and at the return, "kicks" the same backwards, in contact with the leg of uke, leans the free leg on the ground.
3.II) good	Can happen the imbalance. There is an efficient sleeve work, but with the arm slightly abducted in relation to the trunk. The sleeve is unbalancing directed from the elbow to the ground, there is little collar "work", on the other hand with this type of sleeve imbalance, this uke is with his body weight predominating to right leg.	
4) great	Same as (3.I), but there is a great collar work, and the uke is supported with the weight on one leg.	There are docking or approach, the supporting leg (left) moves, and the free leg (right) performs a "kick" forward, and turning back on contact with the leg of uke, continuous to make the "kick" back, finishing the movement with the leg without being in contact with the ground.
Uke: the person being executed. / Tori: who applies the action		

Source: [26].

sports ability, considering the validation of the CHKL of the judo throw: *o soto gari*. The validation of the CHKL was supported by a percentage above 90% of judo experts in content validation, which is an indicator that gives high legitimacy to the CHKL content of the judo throw: *o soto gari* [26].

Experimental design

The participants of the present experiment were randomly divided into three experimental groups: (CG) control group, who received KP in all trials and used visual information related to punctuation (KR), which was present for all subjects of the three groups; WBG (wide bandwidth group), who received KP in the scores according to the rules of the modality: *yuko* or less (occurred when *uke* was projected sideways); NBG (narrow bandwidth group), who received KP in the scores according to the rules of the modality: *wazari* (occurred when *uke* was projected with almost the whole of the back), *yuko* or less.

To ensure that all subjects in the study started the study at the same level of learning, based on the check list of the general stroke configuration, there was an (pre-test) adjustment in the number of subjects for each group. In the pre-test the subjects made 10 attempts, where they received verbal instruction on the pertinent details about the judo throw: *o soto gari*.

The study showed an acquisition phase in which the variable was present, post-test and transfer test that had as characteristic the execution of a task essentially identical to the one realized in the acquisition phase, but with changes in the number of sessions and number of attempts [27] and had as objective to evaluate the capacity of the individual to retain acquired competence [6].

In the acquisition phase the subjects performed three sessions with 30 trials in which the KP was provided according to the group. The subjects received KP viewing the video of the attempted judo throw: *O soto gari* through filming his own

execution. After 10 minutes of the acquisition phase, a post test was performed in which the subjects performed 10 trials without CP. 24 hours after the acquisition phase, a retention test was performed, in which the subjects performed 10 trials without KP.

Experimental procedure

The data collection was performed individually in a suitable room, with controlled temperature, noise level and luminosity. The subjects were asked to use judogi (kimono). Before starting the experiment, all participants were given instructions on how to grab the kimono (*migi kumi kata*). The participants were asked to stand in front of *uke* holding the left collar of *uke's* kimono with his right hand and the right sleeve of *uke's* kimono with his left hand.

Initially the subjects were given verbal instruction along with demonstration of the sequence description of the five elements of the skill through a video of a judo expert, where the ideal patterns of the judo throw *o soto gari* were visualized (Table 2).

Before starting the experiment, each volunteer was informed that the objective of the task was the realization of *uke's* projection with the whole of the back (*ippon*), so that the accomplishment of the throw was as accurate as possible in relation to the established result. During the entry test and the acquisition phase, the volunteers were called to the collection site in pairs, which were the same throughout the experiment.

The subjects participating in the amplitude range groups (WRG and NRG) were instructed to interpret the lack of KP supply as meaning. Thus, the amplitude range groups (WBG and NBG) were informed that if KP was not provided the performance would be considered a hit, that is, when the subject obtained an attempt within the pre-established range in each group, qualitative KP was provided. On the other hand, when KP was provided the performance would be considered a wrong attempt, that is, when the subject obtained an attempt outside the pre-established range in each group, a quantitative KP was provided.

Thus the NBG received quantitative information on all attempts in which the projection runoff was outside the range of points, that is, when the projection result was a *wazari*, *yuko* or less. However, when the score was within the range of points, that is, *ippon*, the apprentice was instructed to interpret the absence of KP as a hit, or that was within the pre-established range (qualitative feedback). However, when the score was within the range of points, that is, ippon, the apprentice was instructed to interpret the absence of KP as a hit, or that was within the pre-established range (qualitative feedback). The WBG received the quantitative information on all attempts in which the projection score was outside the range of points, that is, the result of the projection was a *yuko* or less. However, when the score was within the range of points, that is *wazari* or *ippon*, the apprentice was instructed to interpret the absence of KP as a hit, or that was within the pre-established range (qualitative feedback).

The participants of the CG did not receive quantitative information, that is, they received KP in all the attempts, but without knowing the meaning of the lack of information (quantitative feedback).

A camera (Canon EOS Rebel SL1 18.0 MP) was used in the frontal plane; one camera (Canon PowerShot SX-500) in the left sagittal plane at an intra-camera angle of 45 ° and a notebook (HP Pavilion dv3 Entertainment PC series) aimed

Table 2. Description of the sequence of the five elements of the skill.

a	Advance the left foot next to the opponent's right foot
b	Unbalance the opponent's right upper limb that will leave the opponent leaning only on the right foot.
c	Explanation of the collar imbalance.
d	"Kick" the left leg forward and then back to form the letter "X" the moment the legs meet.
e	Finalize the projection with the leg on the target.

Source: [26].

at reproducing the video and supplying the KP according to the experimental group and the time measurement of the intertentative intervals.

For analysis of the movement, the execution of the throw was made in a closed situation, that is, *tori* and *uke* were stopped. The subjects were filmed performing the task used in this experiment the judo throw: *o soto gari*. The score reached by the participants was scored according to the evaluators' scores and the results of the inter-rater agreement or concordance test [15].

Measures

For the evaluation of the judo throw *o soto gari*, videos were analysed using the CHKL of the judo throw: *O soto gari* on the points to be evaluated using an ordinal scale of 01 to 04. 01 was used, representing a very poor execution of the action, 04 representing a perfect (excellent) execution of the action, to quantify the proficiency of the judo throw: *O soto gari* in the CHKL of the overall configuration. The analysis of the throws was performed twice, with a one-week interval between evaluations, according to the criteria set out in the *kuzushi* and tsukuri scorecard [26].

The group scores were first organized in relation to the score (pre-test, acquisition phase and retention test) and then the scores obtained on the components (intra-class correlation). To ensure consistency between the evaluation of the performance standard of the tested skill, the score obtained by the component (inter-class correlation) was verified. The data were analysed in relation to the score of the score through the mean. The concordance index obtained through the reliability calculation was higher than 85% in all analyses [15].

Statistical analysis

A descriptive analysis was performed, calculating mean values and intra-subject standard deviation in blocks of ten trials. Normality was observed (Shapiro-Wilk test determined that $p>0.05$) and homogeneity (Levene's test determined $p>0.05$). We then used or test two-way ANOVA (3 groups x 3 tests) to perform the intergroup and inter block comparison in the pre-test, post-test and retention test like post-hoc the Tukey test to identify the differences.

RESULTS

In the performance analysis, the groups did not present significant differences in the pre-test, but presented inferior performances to the other tests. In the post-test, all groups showed improvement, and the WBG and NBG amplitude range groups were better than the CG, and the WBG was better than NBG. In the retention test

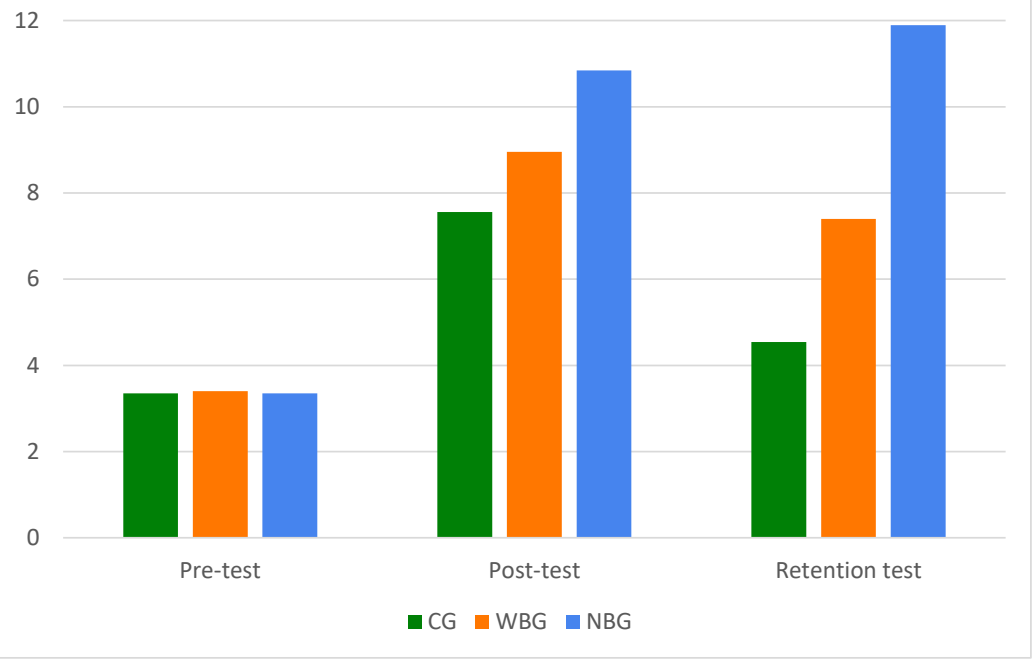

Figure 2. Mean of the score during the entrance test, post-test and retention test.

an improvement of the WBG was observed in relation to the post-test, presenting better than NBG. The NBG kept its performance equal, while the CG decreased its performance (Figure 2).

There was a significant difference in the factor groups [F (2, 33) = 107.68, p<001, r = 0.99]. There was a significant difference in the test factor [F (2, 66) = 383.37, p<001, r = 0.87].

In the post-test, the Tukey test detected that all groups showed significant improvement (p<001) in relation to the pre-test. The WBG and NBG amplitude range groups were significantly higher (p<0.001) to the CG, and the WBG was significantly higher (p<0.001) to the NBG. In the retention test, the Tukey test detected a different behaviour between groups. The WBG and NBG amplitude range groups were significantly higher (p<0.001) to the CG, and the WBG was significantly higher (p<0.001) to the NBG. The WBG group improved their performance significantly (p<0.001) compared to the post-test. The NBG maintained its performance in relation to the post-test and maintained significantly (p<0.003) the trend. The CG did not present significant improvement (p<0.006), presenting a decrease in performance in relation to the post-test.

In the analysis of the performance precision in the pre-test the three groups presented similar behaviours, starting with low levels of score. In the post-test the three groups did not present similar behaviours. The WBG and NBG amplitude range groups were more accurate in relation to CG, with WBG being significantly higher (p<0.001) to NBG. In the retention test the behaviour of the WBG and NBG amplitude range groups were not similar, the WBG showed a significant increase in accuracy (p<0.001), while NBG maintained its performance. The CG differing from the other groups of amplitude range significantly reduced its accuracy.

DISCUSSION

The hypothesis of the study was that there would be a difference between the different bandwidths of knowledge of performance in the acquisition of judo motor skill. The wide bandwidth of performance of the skill would facilitate the acquisition of motor skills. The narrow bandwidth over skill performance would make it difficult to acquire motor skills compared to the wide bandwidth condition. To our knowledge, this is the first time that the beneficial effects of a bandwidth of KP arrangement have been investigated in learning a modality of combat sport.

The results confirmed the hypothesis presented in this study that different bandwidths of KP may have different learning effects. The results also confirmed the hypothesis that the wide bandwidth of KP helps more than the narrow bandwidth or even the KP in all the attempts. The results showed that the bandwidth of KP leads to a greater processing of the intrinsic information and favouring the mechanisms associated with the detection and correction of errors, so the use of the bandwidth of KP to determine when KP is to be presented is an effective method to increase the acquisition of motor skills. It was found also that bandwidth of KP promoted beneficial learning outcomes by reducing error variability and, in the case of WBG, improving accuracy and that both groups of amplitude range were benefited by the qualitative information of goal attainment. The methods for error correction, wide bandwidth of KP and narrow bandwidth of KP can differentiate the effects of learning and the amount of feedback provided in sports skills.

The results verified in the acquisition phase showed that the amount of practice combined with the independent variable was sufficient for an improvement in the performance of the practiced ability, since there was a decrease in both the mean and the standard deviation in all groups in the acquisition phase. Consequently, the differences observed in the retention tests were considered effects of the KP bandwidth. The results of the retention tests of the measures of precision of performance observed in the means of the scores showed that the KP supply in all the attempts of the control group (CG) did not allow a significant improvement in the performance, did not present significant alteration of the components of the ability.

As no changes were detected in the pre-test for the retention test, the absence of changes in CG performance may be related to the amount of KP information. Since the CG received KP in all attempts, the adjustments made to each execution would overwhelm the learner, damaging the processing from the performance information, which would hinder a response to plan the

next execution. In contrast, the results of both the bandwidths groups, the WBG and the NBG showed that there was an improvement in performance, and the wide WBG was significantly better than the WBG. The results of the WBG showed that the KP supply provided an increase in the precision of the execution of the task. Still, following the discussion of the results of the test of retention of the analysis of the average of the escores, it is verified through the results that the KP directed the consolidation of the judo throw: *o soto gari*, showing the importance of the variable feedback in the acquisition of a motor skill.

In this perspective, an explanation for the beneficial effect of the bandwidth of KP in a teaching-learning context was to allow the learners to dissociate, among the different strategies used to perform the task, the strategies that lead to the good performance (efficient strategies) of those which are Ineffective [28]. The results showed that the qualitative information provided only for the bandwidths of KP groups guided the learners towards correct performance, that is an increase in accuracy and a stabilization of performance, due to inherent intrinsic variability to the neuromuscular system [29]. Consequently, the lack of qualitative information reflected a difference in the variables, which may have been a determining factor for not observing an improvement in the CG tests. It is possible to propose that the lack of qualitative interpretation may have been the reason why KP was not beneficial for CG. However, this information was only useful when the learner was able to control the elements of the movement for which the information is provided.

Still, it can be suggested that another aspect that may have influenced the acquisition of the skill practiced in this study was the feedback form (KP), that is, the use of the video allowed the visualization of the execution of the ability, thus, apprentice make the necessary corrections for the integration of various motor actions, resulting in a greater precision in the achievement of the task goal.

Another significant aspect that could be suggested for the WBG result of the other groups in the present study was a lower frequency of KP supply. The results based on the frequency of delivery showed that a lower frequency of delivery in the wide bandwidth of KP method allowed a greater consistency in both performance and precision, which may have led the subject to a better execution pattern, thus enabling the accomplishment of the adjustments needed to improve the completion of the throw and thereby achieve the task goal. The guidance hypothesis [6] may be the explanation for the fact that the WBG with a larger bandwidth presented a lower frequency of supply, resulting in a consistent and precise behaviour, from an information processing perspective. One hypothesis is that the learner obtained greater information processing during the acquisition phase, processing information from intrinsic sources, which is fundamental for the accomplishment of the task without providing feedback.

Thus, the combination of an acquisition phase with small variability and greater use of and with a lower frequency of feedback or external information allowed the improvement of performance [30]. While the NBG with a smaller bandwidth, presented a higher KP supply frequency, causing a greater alteration in the subsequent response and with that increasing the variability of the response, thus, allowing only the maintenance of its performance in the tests. Differing from the other groups, the CG presented a worse performance. These results would be explained due to the dependence caused by the frequent supply of feedback [6].

Together these findings would be explained due to the greater processing of their intrinsic feedback, which in the test condition resulted in the performance of good performances by relying only on the extrinsic information [6]. This hypothesis was confirmed.

The consistency hypothesis [31] failed to explain the fact that the WBG and NBG amplitude range groups showed better performance than the CG. Since in the WBG and NBG amplitude band groups the apprentice did not receive KP in all the attempts during the acquisition phases, which according to the consistency hypothesis is a characteristic of the amplitude range arrangement and consequently would promote trial adjustments for which would constantly change the learner's behaviour in order to decrease the discrepancy of their outcome [32, 12, 33]. This hypothesis has not been confirmed.

Disagreeing with studies suggest that the provision of high feedback frequencies is a method that reduces errors and increases performance

efficiency during skills acquisition [34]. These findings contradict the proposition that extrinsic feedback is unable to inhibit operations that are important for learning such as those resulting from intrinsic feedback [35]. However, a lower KP frequency was required to mobilize cognitive processes and to detect sources of performance information [2, 36].

One of the potentially important aspects of the research is the sensitivity of the effects of the bandwidth of feedback to intra and inter individual differences in performance [37], such as the intertrial interval [36, 38], which corresponds to the time period between the end of an attempt and the beginning of another, separating an execution from the subsequent execution [39]. Studies suggest that there is a learning block, when feedback is instantaneous. This is because feedback is provided in such a way that the interpretation of the intrinsic feedback that emerges from the movement is not allowed [31]. Thus, instantaneous feedback distracts or impedes the student from performing such processing activity upon completion of movement [25].

In contrast, it has been shown that delaying the provision of feedback for a short period of time was beneficial for learning [37]. In this interval it is possible to carry out the operation of analysis of the intrinsic feedback [40], thus strengthening the detection and correction mechanisms of errors [25]. On the other hand, very long intervals can cause decreased motivation, attention and forgetfulness [36, 38], impairing motor learning [41]. On the other hand, studies that used complex tasks did not find favourable results at shorter intervals [36, 38]. These findings showed that the extension of the interval may be related to the characteristics of the task, such as its complexity [41].

The present study measured the time of the intertrial intervals from the analysis of the data collected through the video. The results of the intertrial intervals showed that the shortest intertrial time was 08 seconds and the longest intertrial time was 12 seconds. These results are in agreement with studies that showed that shorter intervals would be more effective for learning motor skills [6], this intertrial interval being less than 16 seconds fundamental for not to be an interference not only in a process, but throughout the process Information processing, mainly involving attention, perception and memory [4, 36, 38]. Thus, the results of the present study provide support for the generalization of principles of the bandwidth of feedback for a complex task. These results support the proposal that the narrow KP bandwidth leads to the best result that its absence, as verified in the retention through the CG, and that the wide KP leads to the best result that the narrow KP bandwidth.

CONCLUSIONS

The results of the present study allow us to conclude that the use of the bandwidth of KP influences the acquisition of complex motor skills, facilitating the learning specifically of a sports skill, such as the judo throw: *o soto gari*. In short, the wide bandwidth helped in the changes of performance and pattern of the movement, favouring the improvement of the consistency and precision. The wide bandwidth of KP helps to learn complex motor skills, and that the narrow bandwidth, while helping to change the execution pattern, was not enough to result in changes in performance. Thus, the study concludes that the wide KP bandwidth is more adequate for sports learning.

The results suggested that the amount of KP delivery frequency can differentiate learning effects a complex ability with many degrees of freedom of the body, highlighting the beneficial effect of qualitative information in the tests. It is questionable if the results of the intertrial intervals between 08 and 12 seconds provided greater information processing, involving mainly attention, perception and memory. These findings demonstrate that unlike simple skills in learning complex motor skills with specific demands there are different components that need to be coordinated to produce a qualified performance and that it is fundamental to provide the learner with the development of sources of intrinsic feedback.

Taken together these findings show that the combination of a lower KP supply frequency, the effect of qualitative information on performance, coupled with an optimal intertrial interval, was the key to the effects of the KP bandwidth on the acquisition of a task complex with specific demands like the judo throw: *o soto gari*. The results suggest the need for further research to address the extent to which the principles for learning a specific complex motor skill can be generalized for learning other complex motor skills.

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