Sports Training

The bandwidth knowledge of results regarding the task of the overhand serve in volleyball

Bruno Roberto Santos[1], Cleber de Souza Lopes[1], Deborah Christina de Oliveira Lopes[2], Márcio Mário Vieira[1]

[1]Universidade Federal de Minas Gerais, Escola de Educação Física, Fisioterapia e Terapia Ocupacional, Departamento de Esportes, Belo Horizonte, MG, Brazil [2]University of Saint Josep, Faculty of Social Sciences and Education, Macau, China.

Associate Editor: Ricardo Barbieri, Programa de Pós-Graduação em Educação Física, Escola de Educação Física e Esporte, Universidade de São Paulo, Ribeirão Preto, SP, Brazil. E-mail: barbieri_ef@hotmail.com.

Abstract - Aim: Motor learning is considered a complex process, providing numerous investigations. Knowledge of Results (KR), a kind of extrinsic feedback, is one of the variables that are used for investigations on motor learning. There are different ways to provide KR to optimize motor learning. The bandwidth KR is one of these forms, being a factor that affects motor learning, however, the specificity of the task needs to be considered in the investigation of this theme. Thus, the objective of the study is to analyze the bandwidth of KR in the acquisition of motor skills of the overhand serve in volleyball. **Methods:** The sample consisted of 24 volunteers of both sexes (12 men and 12 women), 18 to 35 years of age (M = 27, SD = 3.46) and inexperienced in the task. The effect of the bandwidth was analyzed in two groups (with range and without range), in which the volunteers had to learn to control their force by performing the volleyball tennis type service in order to hit a target line. Performance was inferred by the mean and standard deviation of absolute, constant and variable errors. **Results:** There was no statistically significant difference between the groups and the volunteers improved both the precision (absolute error and constant error) and in the consistency (variable error) during the acquisition. There was an improvement in the groups also in the transfer test in the precision measures. **Conclusion:** The variable bandwidth is similar to a control condition in which the volunteers have information at each attempt, causing dependence on external information.

Keywords: motor learning, knowledge of results, bandwidth, force, overhand serve.

Introduction

Feedback is the information received by the performer after performing a movement or motor skill[1], considered as one of the factors that influence motor learning[2], and is divided into two forms: intrinsic and extrinsic. Extrinsic feedback is divided into Knowledge of Performance (KP), which is related to the pattern of movement performed and Knowledge of Result (KR), which is information about the result of the motor action. The KR is considered an important variable in this process, as it serves to supplement information on the return of some motor action[3]. It is necessary for people who cannot detect this information using their sensory system, which can influence the acquisition of motor skills[2–7].

There are different ways of providing KR in which the teacher determines whether KR is provided or not for to learner[2]. However, another way of providing KR without the teacher determining whether KR is provided or not, is through the bandwidth of KR, in which only the error information that exceeds a predetermined range is provided by the researcher[2,8]. The bandwidth of KR differs from other forms of supply, as it is directly related to the learner's performance, that is, his performance determines whether KR is provided or not by the teacher, there is no imposition whether or not the KR will be provided by the teacher[4,9]. When there is an absence of KR, learners are instructed to understand that they have reached the proposed goal[8,10,11].

One factor that has made it difficult to analyze the results on the bandwidth is the context of the task[2,12,13]. The pointless pyramid by Tani et al.[14] clearly shows this analysis when reporting that on the scale of human motor development after 12 years of age, motor skills acquired are culturally determined. Different from the large mass of tasks used in studies on the bandwidth of KR that made use of manipulative or postural control tasks such as pressing buttons, positioning levers or moving objects, tasks considered in the early stages of human motor development[4,15-18]. These tasks are excessively trained

throughout life, reducing the possibility of the effects of a factor, such as KR, appearing in the comparison of experimental groups[7].

Corroborating the difficulty provided by the simplification of the study environment characterized by research with extremely simple tasks, Tani[19] proposes synthesis research as a probable way of testing whether the knowledge already found would corroborate with findings tested in tasks closer to the real world. In this way, we can characterize as an example of these tasks, closer to the real world, those related to sports[20]. Some studies have used sporting tasks[9,21,22] such as netball passes, volleyball serve and golf strokes, respectively, but basing their analysis on task complexity, discarding its context.

Most of the studies found the Bandwidth KR variable using tasks whose researcher has greater control over the intervening variables[4,11,15-18,23-28]. Few studies use tasks that approach a sports context, considered closer to the reality of Physical Education professionals[8,10,21,22].

Smith et al.[22] used the golf task to assess different types of bandwidth to see their effects in sports. The result found was significant for learning only in the measure of consistency (variable error) of the group in which KR was provided through an bandwidth of 10%. Like the study by Coca-Ugrinowitsch et al.[8] used the variable bandwidth in the task of the darts, which is also considered to be a sporting context. And they found a significant result for learning in the measure of consistency (score) of the group that received KR through a narrow bandwidth.

However, Goodwin & Meeuwsen[10] found favorable effects of learning only in the measure of precision (constant error) in the group that did not have bandwidth. Graydon et al.[21], using the netball task, found a result significant only in the precision measure (constant error) of the group witch bandwidth KR. And the study by Ugrinowitsch et al.[9], who used the volleyball overhand serve task, a significant result was found only in the precision measure (score) of the group that received KP through a bandwidth named Wide. These studies used tasks in a sports context.

Thus, after the presentation of the studies above, it appears that it seems that there is no definition as to whether the variable bandwidth KR shows better results in consistency or precision measures when analyzed in a sports context, probably because they are analyzed with different task demands. Publio and Tani[12] raise in their study the need to approach the theory of practice with studies that fit into a situation as close as possible to reality, taking into account that there are more laboratory task studies with limited task complexity (context away from the real world) than practical studies (sports context).

Thus, there was a need for more studies with a predominant task of demanding force control in a sports context. Since, according to the studies found, it cannot be stated that tasks that have a predominance of demand for force control have favorable results for learning in the dimension of consistency or precision. Thus, the objective of the present study is to analyze the effects of the bandwidth KR on the acquisition of the motor skills of the volleyball overhand serve.

Methods

This is a research that has basic and experimental characteristics, considered semi-experimental for comparison between groups. The volleyball overhand serve task was used[9] with measures aimed at characterizing the predominant demand for force control.

Sample

The investigated population consisted of healthy young adults. Sampling was nonprobabilistic for convenience. The sample was recruited by invitation. Posters were posted at the School of Physical Education, Physiotherapy and Occupational Therapy (EEFFTO) at the Federal University of Minas Gerais - UFMG, inviting the volunteers, verbal invitations were also made. Everyone who agreed to participate in the research signed the free and informed consent form (TCLE) and the study was approved by the local CEP (CAAE: 56727716.7.0000.5149). All volunteers declared themselves right-handed and inexperienced in the task.

The sample consisted of 24 young and healthy volunteer adults aged between 18 and 35 years (M = 27, SD = 3.46), of both sexes (12 men and 12 women), all of whom declared themselves right-handed, inexperienced in the task, reached the “GOOD” classification in the checklist of Meira JR.[29] and with free and informed consent. In order not to decharacterize the movement pattern of the service, volunteers were selected who reached the score above 20 and below 25 on the volleyball service check list[29]. Volunteers who reach 20 to 24 points are classified as “GOOD”. Volunteers who did not reach the required score were excluded and replaced, until the number of subjects defined by sample calculation was completed.

The sample was also determined by sample calculation based on the Sampaio study, making the sample size not smaller. Thus, the sample size was estimated at 12 volunteers per group (6 men and 6 women), totaling 24 subjects.

$$\text{Confidence Interval}(CI) = \frac{2 \times \text{Coefficient of Variation } (CV)}{\sqrt{\text{ror n}}}$$

$$CI^2 = \frac{(2 \times CV)^2}{n}$$

$$CI^2 \times n = (2 \times CV)^2$$

$$n = \frac{(2 \times CV)^2}{CI^2}$$

The coefficient of variation was 51.4%, a coefficient of variation considered high. According to Sampaio (2007), for biological variables the chosen CI varies between 5 and 30%, however when the CV is greater than 45%, the CI at the upper limit (30%) is used to calculate the n. In view of this, the sample calculation proceeded as follows:

$$n = \frac{(2 \times 51,4)^2}{30^2} = \frac{10567,84}{900} = 11,7 \text{ or } 12$$

If the volunteer did not return for the second test day (retention), he was excluded from the sample and replaced by another, until the sample completed 12 subjects per group.

Instrument and task

The task consists of controlling force in the volleyball overhand serve, considered a task closer to a sporting context[9]. Figure 1 illustrates the execution of the selected task. The task was chosen because it already has a validated checklist of the movement pattern[29].

The task was performed on a sand court with official measures of beach volleyball. 4 tapes were used on the beach volleyball court to mark the goals, an apparatus to obscure the vision of the volunteers so that they cannot see the result of the action, 10 balls from the brand Penalty volleyball official pro 7.0, an official volleyball net and a laser measuring tape from Bosch® DLE 70 Professional.

To perform the movement pattern of the volleyball overhand serve[29], the camera was placed to record and analyze the pattern so that it captured only the image of the entire body and a space above the volunteer to capture the throw of the ball by the volunteer. This screening had the objective of certifying that the subjects did not decharacterize the movement pattern of the serve and to verify the volunteers who underwent systematic volleyball training. Five trials were performed to analyze the movement pattern. To perform the service, the subjects positioned themselves in the service area (SA) on the "A" side of the court, facing the goal, which will be placed on the "B" side of the court. The objective of the subjects was to reach a goal that is 13 m away from the bottom line on the "A" side, in front of the SA, as shown in Figure 2.

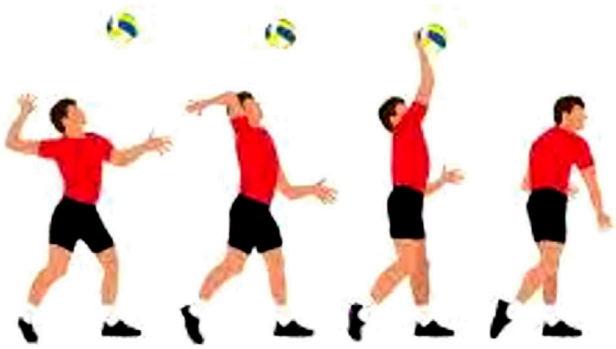

Figure 1 - Overhand serve in volleyball.

The measurement of the error was from the target, in a straight line parallel to the side marking tapes of the court, towards the place where the ball made the first mark closest to the volunteer. A laser measuring tape was used to measure the distance.

In order to ensure that the volunteers did not see the result of their action, a panel was constructed to obscure their vision. This apparatus was placed 1 m away from the bottom line on the "A" side, in front of the "SA", towards the center of the court at a height of 2.10 m.

Experimental design

The selected subjects were randomly divided into a group with an bandwidth (BG) and a control group that did not have an bandwidth (CG), with quantitative KR in all attempts. The error range selected was 10% of the radius that distanced the learner from the target line (goal)[4,10,11,15,22]. In the skill acquisition phase, 60 attempts were made, and the KR was respected for the particularity of each group. The KR delay interval of a maximum of eight seconds between the acquisition attempts was respected[31]. In the transfer tests (10 min after the acquisition phase) and retention tests (24 h after the acquisition phase), 10 attempts were made each, while in the transfer test the target was changed to 12 m from the bottom line of the side "A", ahead of "SA" and in the retention test the goal was kept the same as in the acquisition phase, 13 m. Both tests were without providing Knowledge of Result (KR).

Experimental procedures

Data collection was carried out in an official beach volleyball court, where a day was first scheduled to film the volunteer to analyze the movement pattern. The volunteers watched a video with an experienced model demonstrating the movement pattern of the volleyball overhand serve. The video was shown once for each volunteer containing the repetition of four trials, two in normal speed camera and two in slow speed camera. Then the volunteers were positioned eight meters from the net and were asked to perform five serves after the commands: Prepare, Go! The commands were given before each serve attempt.

After analyzing the footage of the volunteers by the checklist of Meira Jr.[29], two consecutive days with the volunteers were scheduled to perform the task. On the first day, the volunteer performed the acquisition phase (13 m goal) and transfer test (12 m goal) respecting the phases and particularities of each experimental group. All doubts

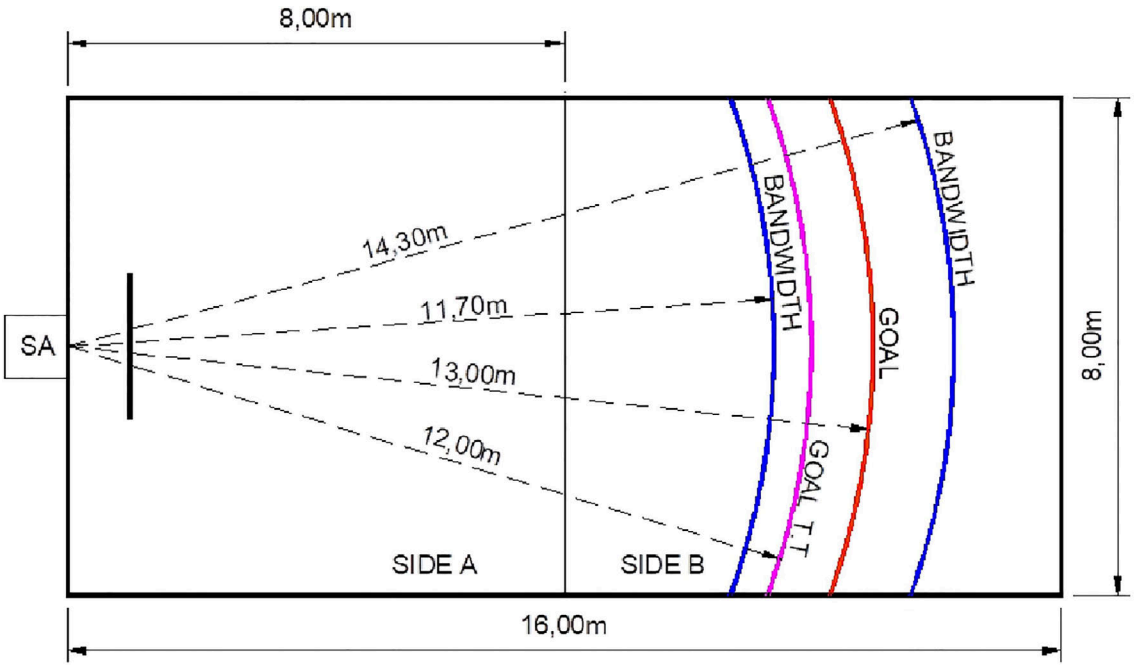

Figure 2 - Volleyball court with goal markings.

that the learners had were clarified before performing the task. On the second day, the retention test (13 m goal) was performed. In all phases, a visual occlusion apparatus was placed 1 m away from the serve's bottom line to prevent volunteers from seeing the result of the action. The information that the volunteers had was of the distance between the first mark of the ball in the sand and the target line.

Performance measures of absolute error (AE), constant error (CE) and variable error (VE) were used. Considering the AE as the difference in module of the distance in a straight line between the first contact of the ball and the target line, the CE as the difference in the distance in a straight line between the first contact of the ball and the target line and the VE which is the standard deviation of the difference in straight line distance between the first contact of the ball and the target line.

Statistical analysis

Descriptive analysis was performed, calculating average values and intra-subject standard deviation in blocks of five trials. Normality (Shapiro Wilks test determined that $p > 0.05$) and homogeneity (Levene test determined $p > 0.05$) were observed. Then, the two-way Anova test was used to perform intergroup and interblock comparison in the acquisition and testing phase, and as a post-hoc test, the Tukey HSD test to identify the differences. The effect size partial eta^2 was calculated and reference values of 0.01 (low), 0.06 (moderate) and 0.14 (high) were used to classify them[32].

Results

According to the error measures analyzed, it was possible to observe that there was learning in both groups (CG and BG) without finding any significant difference between them.

Absolute error

Figure 3 shows that the groups had lower performances in the first few blocks, considerably reducing the error up to the 5th and 6th blocks and remained stable until the 9th and 10th block, increasing the error in the last two blocks. However, this increase in error in blocks 11 and 12 were not enough to achieve the errors in the initial blocks. In the transfer test, the groups worsened their performance in the first block, but significantly reduced their performance in the next block ($p = 0.04$; effect size partial eta^2: 0.17). In the retention test, no specific statistical differences were found ($p = 0.37$; effect size partial eta^2: 0.04) of the blocks, however, the performance was inferior when compared to the last block of the acquisition phase and superior when compared to the first block of the acquisition phase. No significant difference was found between the groups at any stage.

Constant error

When analyzing Figure 4 the predisposition of the groups' performance in the acquisition phase, it was noticed that both groups had a greater error with negative direction at the beginning of the acquisition phase and in the development of this phase the error was reduced. In the transfer test, the groups worsened their performance in

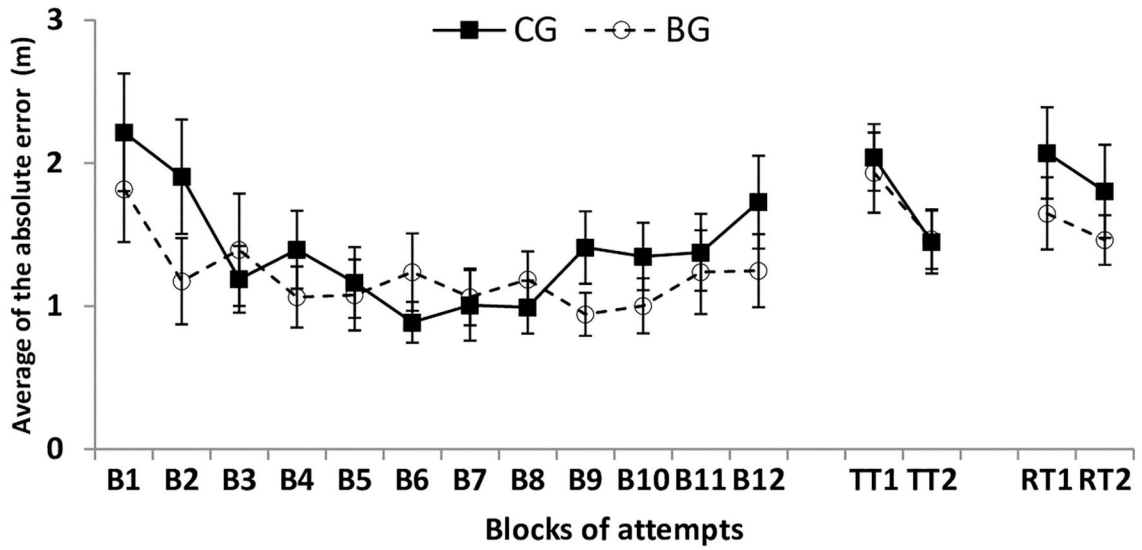

Figure 3 - Average of the absolute error in blocks of 5 attempts (CG – Control Group, BG – Bandwidth Group).

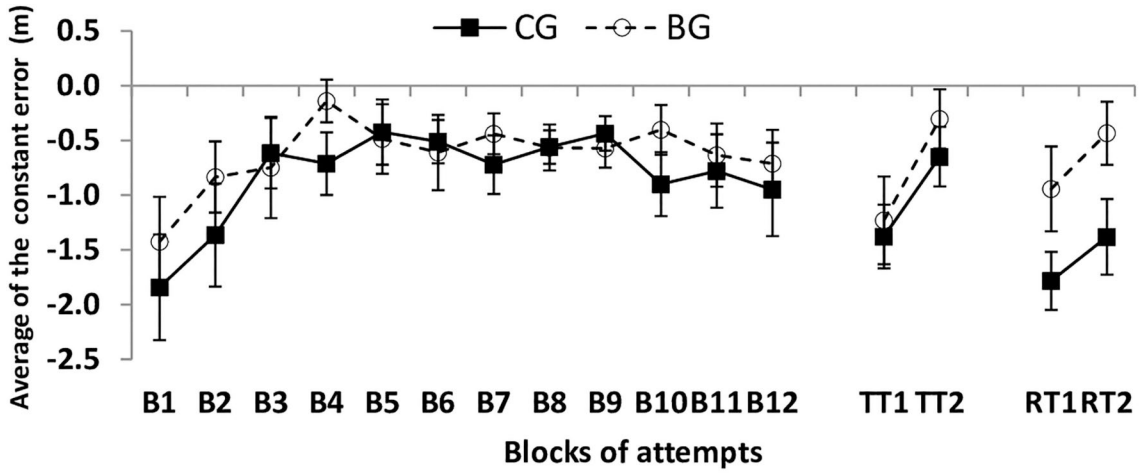

Figure 4 - Average of the constant error in blocks of 5 attempts (CG – Control Group, BG – Bandwidth Group).

the first block in relation to the last block of the acquisition phase, but significantly reduced the error in the second block ($p = 0.002$; effect size partial eta^2: 0.36). In the retention test, although no significant difference was found between the groups ($p = 0.06$), the first block of the BG performed similarly to the last block of the acquisition phase, reducing its error in the second block (effect size partial eta^2= 0.15). The CG had a worse performance when compared to the last block of the acquisition phase, but better performance than the first block of the acquisition phase. No statistically significant difference was found between groups at any stage.

Variable error

When analyzing the consistency of the groups in the acquisition phase, it was noted in Figure 5 that there was no statistically significant difference ($p = 0.74$; effect size partial eta^2: 0.03), but the CG had a reduction in the variation from block 5 to 6, again varying similarly to the BG group in block 8. The BG reduced the variability from the first to the second block and maintained the regularity of variation. In the transfer test, both groups varied more than the skill acquisition phase. Although no statistically significant difference was identified between the blocks ($p = 0.06$), both groups had an increase in variability in the first block and a reduction in the second block compared to the last block of the acquisition phase (effect size partial eta^2 = 0.15). In the retention test, the groups' variability was not statistically significant ($p = 0.14$; effect size partial eta^2: 0.09), and both groups had reduced variability when compared to the first block of the transfer test, being similar to the last acquisition phase block.

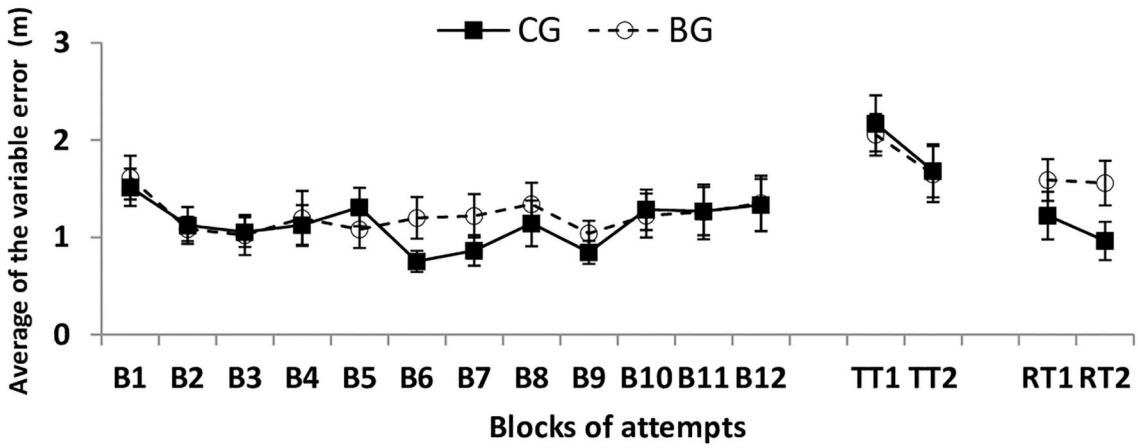

Figure 5 - Average of the variable error in blocks of 5 attempts (CG – Control Group, BG – Bandwidth Group).

Discussion

The aim of the study was to analyze the effects of the KR banwidth on learning of a sports context task, the volleyball tennis service. The learning of force control was tested with the volleyball tennis serve task. Volunteers of both sexes aged 18 to 35 years divided into two groups: an experimental group, with a range allowed for error; and a control group, with no allowed error range. No method similar to the present study was found in any study. Studies that used this task used score measures with a circular target to analyze KP or did not aim to analyze the bandwidth of KR[9,33,34].

Through the measure of precision of the absolute error it was possible to observe the reduction of the error during the phase of the skill acquisition, which allows to infer that there was learning in both groups. Ratifying the study by Ugrinowitsch et al.[17] that uses an instrument with the main demand of force control, a sample composed of young adult university students of both sexes, but in a previous context away from the real world and found no statistical differences between the experimental groups of allowed range for error (5%, 10% and 15%) and with no allowed range for error (0%); all groups reduced the error during the acquisition phase. Also corroborating the studies by Goodwin and Meeuwsen[10], which uses a task with a predominance of force control, Golf, with a sample composed of young female university students; Lee and Maraj[25] and Butler at al.[26] who used a task that had a temporal demand as the main one, with a sample composed of young university students of both sexes. These studies also lead to a reduction in the error in the acquisition phase from the first to the last block. In relation to the transfer test, a significant difference was found between the blocks, with the first block having a greater error than the second. Ratifying Coca-Ugrinowitsch and Ugrinowitsch[23] and Ugrinowitsch et al.[17] in relation to the statistical difference between the blocks, the increase in the error in the first block and the reduction in the error in the second block of the test, with a sample also composed of young adult university students of both sexes.

Through the other precision measure, constant error, a larger error was found in the negative direction of the first block in the constant error acquisition phase, followed by a reduction in the errors in the following blocks. The present results do not corroborate the study by Junqueira et al.[18] in relation to the measures of the first block of constant error, which had a sample also composed of young adult university students of both sexes, in which some groups started with an error in the positive direction and others in the negative direction. This fact may have occurred due to the demand for the task, causing different strategies to be reached to achieve the goal[35]. Regarding the transfer test of the present study, as well as the absolute error measure, a significant difference was found.

Through the measure of consistency, the variable error, it was observed that the variability decreased during the acquisition phase in both groups. Corroborating studies by Smith et al.[22] who used a task with predominance of force control, but in a sporting context, Golf; in which there was also a reduction in the variability in the feedback conditions. It also corroborated the study by Coca-Ugrinowitsch and Ugrinowitsch[23] that used a task in a context away from the real world with a predominance of demand for force control, the dynamometer. In addition to the study by Lee and Carnahan[15] who used a task with a predominance of temporal demand and in a context away from the real world. Thus, from the analysis of the present studies and previous studies, it can be inferred that regardless of the characteristics of the task, the variability of the error reduces with the development of the acquisition phase. Noting that the studies cited were composed of young adult university students of both sexes.

Regarding the retention test, no significant difference was detected in any factor (groups and blocks) in the measures of absolute error, constant error and variable

error. Going against the study by Ugrinowitsch et al.[9] who identified through the delayed retention test a significant difference in two criteria that were evaluated in the group that had a wide bandwidth allowed for error. The retention test detected learning, considering that the errors in the studies were lower in the test compared to the first block of the acquisition phase. However, it is noteworthy that the sample consisted of children of both sexes with an average age of 11.2 years (+ 4.1 months).

After analyzing the results, it is noted that even with an average frequency of supply of KR of 38.33% for the bandwidth group, the groups had similar results. In this way it is perceived that the form of the variable bandwidth of KR is seen, as if it provided KR in all attempts[2] is the most ideal. Because it was noted that the volunteers had access to information in all attempts, be it quantitative (when the learner fell outside the permitted range for error and the experimenter reported his error) or qualitative (when the learner fell within the permitted range for error, occurring an absence of quantitative KR, making the learner understand that he has reached the goal).

Despite analyzing the effects of KR bandwidth in a task that is not in a sports context, the study by Agethen and Krause[36] obtained results similar to the present study: no difference was found between the groups, only in the analysis of automation of tasks (a sequence move the arm). Four groups were analyzed: control group, group with 100% feedback, group with 10% bandwidth and group with 10% bandwidth-yoked.

From the results of the present study it seems that there is a learning effect both in precision (absolute and constant error) and in consistency (variable error). Taking into account both the skill acquisition phase and the tests. Learning in the task was identified with a predominance of force control in a sports context and there was no statistically significant difference between the groups. Regarding the measures of precision and consistency, regardless of the predominant demand of the task, it seems that the variability reduces and the precision increases with the progress of the attempts.

Conclusions

Because no difference was deteded in the groups during the study, it was concluded that the variable bandwidth is similar to a control condition in which the volunteers have information at each attempt, causing dependence on external information. This inference was assumed even in situations where the p-value was 0.06 and the effect size partial eta^2 was considered high (Constant error retention test phase and variable error transfer test), and in the situation in which the p-value was 0.04 and the effect size partial eta^2 was high (absolute error transfer test phase) due to the sample calculation performed[30].

In this way, it can be inferred that, regardless of whether the learner receives information about the result from the teacher or not (quantitative feedback), he has feedback in all trials, because when he does not receive information from the teacher, he understands that he has been successful, and this information is received (qualitative feedback).

As a suggestion for future studies, verify if the type of feedback (quantitative or qualitative) can influence learning, taking into account the demand of the task performed (sports context or not). Also as a suggestion for future works, taking into account another type of volleyball serve, compare the learning of people with experience in volleyball with different levels (amateur and professional).

The study by Shimony et al.[37] used a sport context task (Goalball) to analyze which size of bandwidth would result in better accuracy and consistency in throwing the ball among visually impaired players. Concluding that wide bandwidth are better than narrow bandwidth. One can then suggest another study that takes into account task demand and size of bandwidth.

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Corresponding author

Bruno Roberto Santos. Universidade Federal de Minas Gerais, Escola de Educação Física, Fisioterapia e Terapia Ocupacional, Departamento de Esportes, Belo Horizonte, MG, Brazil.
E-mail: brunosantosedfisica@gmail.com.

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