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PRECISE VERBAL FEEDBACK MAY EXPEDITE THE ATTAINMENT OF STANDING LONG JUMP ACCURACY IN WOMEN

Mirosław Zalech and Zbigniew Bujak

Faculty of Physical Education and Health in Biała Podlaska, Józef Piłsudski University of Physical Education, Warsaw, Poland

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Abstract:

The purpose of this study was to determine whether the precision of verbal feedback affected the accuracy of a standing long jump performance. Sixty-eight female participants (M age=21.44±1.01 years) were randomly assigned to two experimental groups. In total, each subject performed nine jumps at three distances: 50 cm (3 trials), 75 cm (3 trials) and 100 cm (3 trials). Group 2 performed jumps in a reverse order. During the task execution, the study participants received verbal feedback at different levels of precision (no feedback; information that the jump was either: *too far*, *close*, or *correct*; information about the distance in centimetres). The results of statistical analysis indicated that the speed of changes in jump accuracy depended on the precision of verbal feedback. The difference between an actual jump result and a target result increased proportionally with jump length. With a large number of trials, verbal feedback accuracy does not affect significantly the precision of women's long jump performance. However, when the high accuracy of task performance needs to be obtained quickly, feedback ought to define the exact difference between the target and the actual jump results. The current findings also indicate that providing no feedback does not contribute to improving motor task performance accuracy.

Key words: *auditory feedback, performance, knowledge of results, motor skills*

Introduction

Feedback provided after completing a task refers to some aspects of task performance and is intended to reduce differences between the desired and the actual outcomes (Hattie & Timperley, 2007). Verbal instructions and feedback exert an enormous influence on the learning process and contribute to a proper task performance (Abdollahipour & Psotta, 2017; Maxwell, Masters, Kerr, & Weedon, 2001). When attempting to perform motor skills correctly, two types of feedback apply. The first one, known as the internal feedback, is received through the performer's proprioceptors and the visual system, and it provides knowledge of motor activity. The second one, the external feedback, provides knowledge of motor skill elements and the degree to which the motor activity execution succeeded with regard to a skill model or goal. Augmented feedback, consisting of both the intrinsic and extrinsic information, enables task performers to identify the differences between the actual and the model task performance and to try to reduce them (Magill, 2000; Schmidt & Lee, 2005). Thus, augmented auditory feedback on knowledge of results (KR) and knowledge of performance (KP) is a valuable source of information needed to maximise motor skill performance. In education and sport, augmented auditory feedback is a basic form of communication used to instruct and correct improper task performance (Landin, 1994). In augmented auditory feedback, there are two components: auditory stimuli (Barros, Florendo, & Le, 2014; Hutchinson, et al., 2011; Liu & Jensen, 2009) and verbal instructions (Magill, 1993; Porte, Xeroulis, Reznick, & Dubrowski, 2007; Welling, Benjaminse, Gokeler, & Otten, 2016); each of these differ in how they provide KR. Auditory alarms represent dichotomous equivalents of verbal indications of either correct or incorrect task performance. Sonification is a continuous equivalent of a more precise KR. Verbal feedback is received with a greater delay than simple auditory stimuli (Sigrist, Rauter, Riener, & Wolf, 2013), since it requires greater effort and processing time from both the feedback provider and recipient.

Verbal information not only provides feedback but also helps the recipient to regulate physiological stimulation (Andreacci, et al., 2004). The contents of verbal feedback may affect motor skill performance in different ways. Wulf, McConnel, Gärtner, and Schwarz (2002) revealed that it was possible to enhance the effectiveness of learning tennis serves in volleyball without referring to the performer's own movements (e.g. *toss the ball high enough in front of the hitting arm*), but by directing his/her attention to space (e.g. *toss the ball straight up*) and to the movement goal, or by making comparisons with other movements (p. 174). The research (Wulf, et al., 2002, Experiment 1) showed that external-focus feedback increased accuracy of the serves in both practice and retention. However, internal-focus feedback is more beneficial than the instructions considering movement outcome when the task requires information about the effective pattern of movement with slight adaptation of this pattern to environmental constraints of the task (James, 2012). In the case of considerably more demanding (complex) technical skills, providing internal-focus feedback on movement effectiveness does not result in permanent performance improvement. The opposite is true when it comes to the feedback provided by an instructor (Porte, et al., 2007) because the instructor provides his/her trainees with a more comprehensible, concise, constructive and broad feedback which helps trainees in getting to know the structure of movement better and leads to a stronger cognitive representation of the task and a more accurate task performance.

Providing verbal instructions and signals is one of the most common behaviours in the process of physical and sports education. Informing and giving feedback are basic didactic behaviours of teachers/instructors/coaches. Zeng, Leung, and Hipscher (2010) demonstrated that specialist teachers devoted the smallest amount of time to explaining, reviewing, demonstrating and summarising (approx. 25%), whereas senior college students (with about seven months of teaching experience) spent the greatest amount of time performing these activities (approx. 46%). Providing specific feedback regarding tasks took up about 13% of specialist teachers' time and only 3% of students' time. Verbal signals and phrases used in training are usually concise and consist of just a few words. They draw students' attention either to proper stimuli and effects, or to key elements of the model task (Cutton & Landin, 2001; Zatoń & Szczepan, 2014).

Currently, a lot of studies have focused on the effects of instructions and feedback on results. These studies involve providing different types of KR in the form of opinions (Wu, Porter, & Brown, 2012; Wulf, et al., 2002), points (Palmer, Chiviacowsky, & Wulf, 2016; Saemi, Porter, Ghotbi-Varzaneh, Zarghami, & Maleki, 2012) as well as vertical definition of performance accuracy: *right*, *left*, *near*, *far* (Ávila, Chiviacowsky, Wulf, & Lewthwaite, 2012). However, the relationship between the precision of verbal feedback and motor skill performance has not been fully investigated yet. Since the reception of stimuli in the process of school and sports education is limited, feedback ought to be concise and it should consist of just a few words in order not to overload learners and disrupt their physical activity (Landin, 1994). Controlling the structure of verbal communication results in an increase in feedback effectiveness. Therefore, one purpose of the present study was to examine how the precision of augmented feedback affected the accuracy of standing long jump performance. It was assumed that a more precise verbal feedback would contribute to a more accurate motor skill performance and led to a reduction in time needed to achieve this accuracy. It is in line with previous findings that verbal feedback precision is conducive to learning skills (Masser, 1993). Having analysed the research on transfer in motor skill learning (Maxwell, et al., 2001; Palmer et al., 2016), the authors hypothesised that practice would result in significant differences in the accuracy of standing long jump performance between various distances.

Methods

Participants

Young female students (N=68, M age=21.44 years, SD=1.01) took part in the study. All participants were naive to the purpose of the study. Prior to the commencement of the investigation, the approval from the Senate Ethics Committee of the University of Physical Education in Warsaw was obtained and informed written consent was given by each participant. All subjects had previous experience in doing the task, but they had never performed it according to this study protocol. They were screened to make sure that they had not done any professional sports and had not received formal long jump training in the period of one year before the experiment. If the students had experiences any of the two situations, they were excluded from the participant pool.

Apparatus and task

The tests were carried out in a sports hall with a wooden floor. The participants performed nine targeted standing long jumps, i.e. they made three trials at each of the following distances: 50 cm, 75 cm, and 100 cm. They were not provided with any feedback when performing the first task (both groups 75 cm). Following the next jump task (both groups 75 cm), they were informed about the distance to the target using words like: *too far*, *close,* or *correct*. After the last task (E1=100 cm, E2=50 cm), the participants were given exact results (in centimetres) that they had achieved. The subjects performed the jumps barefoot. The take-off place was marked with a white line. Distance measurement was made from the take-off-line (where the toes were situated before a jump) to the back of the heel that was closer to the take-off- line after landing. Measurements were made with the laser distance meter after each of the nine jumps, immediately upon landing. Such measurements guaranteed that the study participants could not see how far they had jumped; they only received this information in the form of verbal feedback.

Procedure

The study participants were randomly assigned to one of the two experimental groups (E1 and E2). Group E1 consisted of 34 women ($M_{age(years)}$=21.38, SD=1.00; $M_{body\ mass(kg)}$=60.77, SD=6.53; $M_{body\ height(cm)}$=167.47, SD=7.40). Group E2 included 34 women ($M_{age(years)}$=21.49, SD = 1.02; $M_{body\ mass(kg)}$=60.12, SD=6.49; $M_{body\ height(cm)}$=167.97, SD=6.06). Two weeks prior to the experiment, after a 5-minute warm-up, the subjects performed three maximum effort standing long jumps. In group E1, the mean result was M=169.53 cm, SD=11.16, while in group E2 it was M=170.18 cm, SD=16.66. The results were used to establish if the tasks would be hard to perform. It was observed that the 50 cm jumps were in the range of 24.57 to 36.23% of the participants' maximum capabilities, 75 cm jumps – between 36.86 and 54.35%, while 100 cm jumps involved from 49.14 to 72.46% of their maximum capabilities. The findings showed that the participants' levels of fitness would not hinder their motor skill performance. The tasks were performed individually under identical conditions, during one session and in accordance with the same protocol (see Figure 1). Before the start of the experiment, each participant performed the same 4-5-minute warm-up consisting of 10 exercises repeated 10 times each. The participants were instructed to assume a starting position prior to each jump, i.e. to stand behind the line with their feet shoulder-width apart and then leap forward. Afterwards, the students were informed that they would have to perform nine standing long jumps at precise distances from the take-off place marked with a white line and they got acquainted with the distance measurement protocol. They were also told that they would perform three trials at each of the three distances and that they needed to hit the target. The E1 group members were asked to perform first the 50 cm standing long jumps (three trials), 75 cm jumps (three trials), and 100 cm jumps (three trials), whereas the subjects from group E2 did the same tasks in the reverse order, i.e. 100 cm jumps first (three trials), then 75 cm jumps (three trials), and 50 cm jumps at last (three trials). Both groups received the same types of feedback in the same order. After jumps 1, 2 and 3 (task 1) no feedback was given to them. After jumps 4, 5 and 6 (task 2) they were informed about the distance to the target using words like: *too far*, *close,* or *correct*, while following jumps 7, 8 and 9 (task 3) the participants were given exact results (in centimetres) they achieved. They did not see the target before jumping or after landing. They were informed about the distance they were expected to achieve prior to the jump. After each jump in tasks 2 and 3, the participants were given verbal feedback on their results.

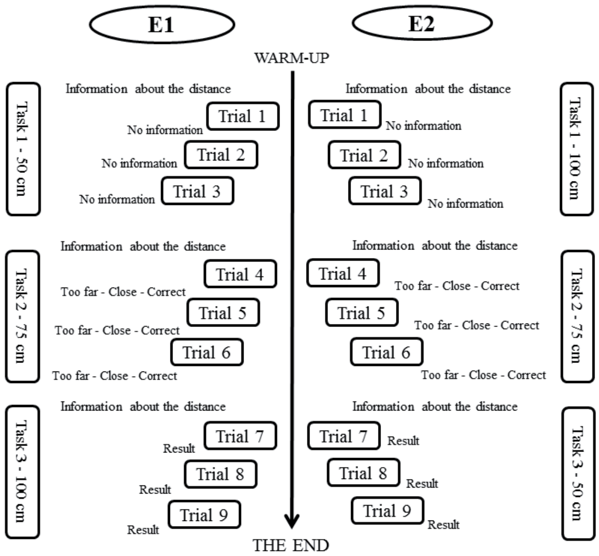

Figure 1. Protocol followed by the two groups.

Data analysis

An independent *t*-test was employed to determine significance of differences between the features describing participants from the groups. The percentage of absolute constant error (%|CE|) of the distance achieved by each participant was a dependent variable. Constant error (CE) was calculated by subtracting a target result from an actual jump result. The result obtained for each participant was recorded as the absolute value (|CE|). %|CE| was obtained through dividing |CE| by the target result and multiplying it by 100. Lower %|CE| means a more accurate performance. This measurement method reflects mean deviation in both directions and makes it possible to assess jump performance in relation to the target result (Patterson & Carter, 2010; Schmidt & Lee, 2005; Simon & Bjork, 2002). Jump accuracy was analysed in the set of 2 (Group) x 3 (Task) x 3 (Trial) with the factorial analysis of variance with repeated measures (mixed-design ANOVA). Alpha <.05 was considered significant in all analyses. In order to estimate effect sizes for significant results, partial eta-squared values (η_p^2) were calculated. Tukey's *post-hoc* HSD test was employed to analyse significant effects. D Cohen values were calculated according to the following formula:

$$d=(M2-M1)/SD\ pooled \quad \text{[Equation 1]},$$

where $SD\ pooled = \sqrt{[(SD1^2 + SD2^2)/2]}$ [Equation 2].

Differences between means were considered to be small when $0.2 \le d < 0.5$, medium when $0.5 \le d < 0.8$ and big when $d \ge 0.8$ (Cohen, 1992). Mauchly's test of sphericity was used to assess sphericity. If the assumption of sphericity was violated, p values were corrected using Huynh-Feldt procedures (Huynh & Feldt, 1970).

Results

The analysis of results revealed that groups E1 and E2 did not differ significantly in age t(66)=.48, body mass t(66)=.41, body height t(66)=.31, or maximum standing long jump distance t(66)=.19, p>.05.

Figure 2 shows the scores achieved during targeted jumps. The results are presented in the form of mean percentage values of the absolute constant error.

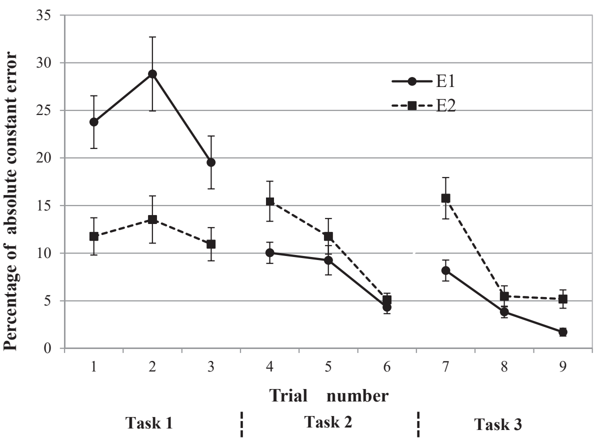

Figure 2. Mean percentage values of the absolute constant error regarding practical performance of nine trials in groups E1 and E2. Error bars represent standard error.

The feedback provided in tasks 2 and 3 contributed to an improvement in standing long jump accuracy. Although the types of feedback received while performing each of the two tasks were different, the difference in jump accuracy was marginal. This observation was supported by a significant task x trial interaction F(4, 132)=7.10, p<.001, η_p^2=.18, the main effect of the task F(2, 66)=53.06, p<.001, η_p^2=.62, and the main effect of the trial F(2, 66)=32.78, p<.001, η_p^2=.50. Multiple comparison *post-hoc* testing revealed that when no feedback was provided (task 1), no improvement in jump performance accuracy was noted. The study participants performed more accurate jumps in tasks 2 and 3. It was confirmed by significant differences between trial 4 (M=12.75) and trial 6 (M=4.71) (p<.001, d=1.06) as well as between trial 7 (M=11.97) and trial 9 (M=3.44) (p<.001, d=1.04). Experience gained when performing the first task proved to affect the accuracy of jump performance in tasks 2 and 3. Significant differences were found between trial 1 (M=17.77) and trial 4 (p=.021, d=.39) as well as between trial 1 and trial 7 (p=.003, d=.45). Experience gained while performing task 2 did not result in jump performance improvement after changing the distance in task 3 (no significant differences between trials 4 and 7). Provision of verbal feedback led to a significant improvement in jump performance accuracy, while no progress was observed when no feedback was given. *Post-hoc* tests revealed significant differences between trial 3 (M=15.24), which was the final trial of task 1 (no feedback), and trial 6, which was the final trial of task 2 (feedback about the distance to the target provided with the use of words like: *too far*, *close,* or *correct*) (p<.001, d=1.03) as well as trial 9 (the final trial of task 3, where feedback was given in the form of a precise result expressed in centimetres) (p <.001, d=1.14). No significant differences were noted between trial 6 (task 2) and trial 9 (task 3). The level of task performance in the first trials of tasks 2 and 3 (trials 4 and 7) was not significantly different. This means that jump accuracy after receiving verbal feedback on the distance to the target (*too far*, *close* or *correct*) (trial 6) did not differ significantly from jump accuracy after receiving verbal feedback on the exact distance achieved (trial 9). *Post-hoc* tests also showed that jump accuracy in task 3 improved at an initial stage, where a significant difference between trials 7 and 8 was found (M=3.38) (p<.001, d=.88). In task 2, accuracy improvement was noted in the second phase, where a significant difference between trial 5 (M=7.88) and trial 6 (p=.003, d=.77) could be seen. These results show that the study participants improved their performance accuracy significantly faster when feedback was provided in the form of a precise result (expressed in centimetres). When feedback using words: *too far*, *close,* or *correct*, was given, significant accuracy improvement occurred later.

The ANOVA revealed a significant group x task interaction F(2, 66)=29.64, p<.001, η_p^2=.47. Subsequent *post-hoc* tests on the experimental groups indicated that in task 1, group E1 (M=24.04) and group E2 (M=12.08) differed significantly in jump accuracy (p<0.001, d=.76). With no feedback, %CE was greater in 50 cm jumps than in 100 cm jumps. No differences between groups E1 and E2 in tasks 2 and 3 were found. The main group effect was not significant F(1, 33)=1.04. Also, the interactions of group x trial, F(2, 66)=1.55, and task x trial x group, F(4, 132)=1.64, ps>.05, were not significant.

Discussion and conclusions

The aim of this work was to analyse the influence of feedback on the precision of standing long jump performance. It was predicted that after receiving feedback on performance and the distance to be jumped, accuracy would improve after each subsequent trial. This assumption was based upon the hypothesis put forward by Lee, Keh, and Magill (1993), who claimed that in some cases, motor tasks could be taught without feedback if proper instructions were given to a learner. It was assumed that performance would improve after the internal feedback provision. It turned out, though, that when trials were preceded by instructions only (without augmented feedback), no significant improvement in jump performance accuracy was noted. Thus, with a low number of trials, performance improvement is not produced on the basis of internal feedback only. However, due to the limited scope of the research, it was not possible to prove that providing instructions only could not result in jump performance improvement. Therefore, more detailed experiments would have to be carried out to draw valid conclusions regarding the relationship between instructions and jump accuracy.

In task 1 (no feedback), mean %CE of the distance was approximately twice smaller when the distance jumped was twice longer. Previous findings regarding the estimation of relatively short distances did not confirm our results. They revealed that an ability to estimate the distance up to 40 cm was very good, but it decreased rapidly together with an increase in the distance (Viguier, Clément, & Trotter, 2001). The difference may result from the experimental arrangement as well as the estimation method (estimation was performed by study participants at eye level). Information concerning the distance is processed by a perceiver, and it depends on a number of factors that allow the perceiver to visualise the manner and range of movement performance (Witt & Proffitt, 2008). For instance, estimation accuracy depends on perceived effort associated with performing a given task (Proffitt, Stefanucci, Banton, & Epstein, 2003), or on previous experience (Mori, Ohtani, & Imanaka, 2002).

Previous studies revealed that differences in the contents of feedback on motor skill performance affected the results (Tzetzis, Votsis, & Kourtessis, 2008). Regardless of sex, instructions that focused on the target rather than movement helped to maximise standing long jump performance (Porter, Ostrowski, Nolan, & Wu, 2010; Wu, et al., 2012). Sometimes, better performance was noted when instructions concerned movement form (James, 2012). It means that the influence of instructions and feedback on the progress may depend on whether internal or external focus was involved and on the feedback contents (Munzert, Maurer, & Reiser, 2014). Our findings showed that with a minimum of three repetitions with external-focus feedback, it did not matter what the precision of that information was. Both types of feedback resulted in the examined women performing jumps at a comparable level of accuracy. It indicates that verbal feedback may help to achieve the same effects in a different manner (Zentgraf & Munzert, 2009).

The results of the present study partially confirmed the hypothesis of the influence of practice on jump accuracy after changing task parameters (the distance). An improvement in performance accuracy was noted after the first change of parameters, while no differences were found after the second change. It turned out that the first distance change acted as a stimulus that led to an improvement in jump accuracy. The second stimulus in the form of the next distance change did not result in outcome improvement even though the study participants were provided with augmented feedback between the first and the second distance change. It shows that with a low number of repetitions, a significant transfer of jump performance accuracy may occur. Unfortunately, it only occurs up to a certain level of accuracy. It may be accounted for by the fact that sensory and perceptual processes, which are coordinated with one another and activate the same cortico-subcortical systems, adapt to new conditions quickly (Doyon, et al., 2009). This observation is supported by the statement that providing instructions without augmented feedback may also contribute to an improvement in jump performance accuracy. However, further research is needed to explore this issue thoroughly.

The precision of feedback was a critical factor for the speed of jump accuracy improvement. Knowledge of the exact result led to a quick accuracy improvement at the beginning. However, at a later stage, the improvement was considerably smaller. When feedback was provided in the form of phrases like *too far*, *close,* or *correct*, accuracy improvement was minor. Nonetheless, the improvement slowdown was not as fast as in the case of trials where feedback included information about the distance (in centimetres). A slower pace of accuracy improvement is linked to the limitations of a less precise feedback. In this case, task performers' ability to assess the differences between the model and the actual performance is hindered. For this reason, they do not know exactly to what extent they ought to improve their performance (Sigrist, et al., 2013). Therefore, with a less precise feedback, improvement occurs more slowly but also more steadily than with feedback on the distance expressed in centimetres. Visualising the model movement is of great importance. When motor skill performers are allowed to have access to feedback at any time, they ask for it mainly at an initial stage of task performance (Wulf & Toole, 1999). In this way they want to obtain the most precise movement model in the fastest possible way. Therefore, it may be stated that the precision of feedback on movement affects performance accuracy. When a lot of trials with less precise feedback are performed, the same outcome is achieved as in the case of fewer trials with a more precise feedback.

It can be concluded that at first great differences in perceiving the model occur when both less and more precise types of feedback are provided. In the following trials, the required model is becoming similar for both types of feedback. This process is slower in men (Zalech & Bujak, 2018). Therefore, it may be presumed that a relative stabilisation of performance accuracy occurs when performers approach their physical and mental limits. Moving these boundaries is an extremely slow process that requires a lot of time and effort. It occurs during motor skill improvement.

In conclusion, our findings allow us to infer that precision of feedback on the result achieved affects the speed of obtaining standing long jump accuracy in females. This observation is of both educational and practical value not only for physical education but also for any activities in which accuracy and movement duration are of great importance. In the case of a limited number of repetitions and frequent changes in motor skill parameters, verbal feedback ought to determine deviations from the model in the best possible way. When there are many more trials, feedback tends to be less precise. The outcome of motor skill performance accuracy will be similar in both cases. However, the number of trials in which it will be achieved will be different. The research results also indicated that self-learning with a low number of trials did not contribute to a considerable accuracy improvement, but it may become a preparatory element that would make it possible to use internal feedback in a conscious manner. Further research is necessary to address this issue more thoroughly. It would also be interesting to find out if the study results could be generalised to complex motor skills as well as other populations.

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Corresponding author:
Mirosław Zalech, Ph.D.
Józef Piłsudski University of Physical Education in Warsaw
Faculty of Physical Education and Health in Biała Podlaska
Akademicka 2, 21-500 Biała Podlaska, Poland
Tel. +48 83 342 87 84
Fax: +48 83 342 88 00
E-mail: zalech.miroslaw@gmail.com