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The effect of the transition command on the long jump performance by visually impaired athletes

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ORIGINAL ARTICLE

ABSTRACT

This study investigated the effects of transition command related to caller location (front, back, right and left side of the take-off board) and type of caller communication (voice and clap hands) on the long jump performance by visually impaired athletes. Eight long jumpers with visual impairment (T11 class), both male and female, with an average age of 26.35 years (± 6.29), and their respective callers (n = 5) took part in this experiment. Two conditions were experimentally manipulated: (i) caller location and (ii) type of communication. Two long jumps were performed in each location under each type of communication, totalizing 16 long jumps per athlete. Results showed that type of command, as well as the callers' locations, affected similarly the performance of the long jump by visually impaired athletes. They also showed that athletes and callers' preferences for the type of transition command and positioning location had the same effects.

Keywords: auditory control; Paralympic sport; long jump; visual impairment.

INTRODUCTION

Long jump is one of the oldest motor skills performed in competitions (Miller, 2004). It refers to a specialized motor skill composed by the sequential interaction of five components or phases: concentration, running (approaching), take-off (impulsion), flight, and landing.

Although long jump is formed by the components described above, the transition from running to take-off has been recognized as that key-aspect of successful performances (Berg, Wade, & Greer, 1994; Lee, Lishman, & Thomson, 1982; Mood, Musker, & Rink, 2011; Scott, Li, & Davids, 1997; Seyfarth, Friedrichs, Wank, & Blickhan, 1999; Torralba, Padulles, Losada, & Lopez, 2017), because such transition implies transferring the horizontal velocity acquired during the running into the take-off (Derse, Hansen, O'Rourke, & Stolley, 2012; Schmolinsky, 2006). To put it in another way, the most efficient take-off angle to remain in the flight for longer is dependent on the minimum loss of horizontal velocity of running (Bayraktar, 2017; Mood, Musker, & Rink, 2011; Tan & Zumerchik, 2000; Willwacher et al., 2017).

On this concern, studies have shown that long jump athletes adjust the strides length and/or velocity during the last stages of running (e.g., about 5 meters before take-off board) in order to optimize their arrival to the take-off board (Berg, Wade, & Greer, 1994; Lee, Lishman, & Thomson, 1982; Torralba et al., 2017). Such adjustments occur based on visual control of approaching to the take-off board (Bradshaw & Aisbett, 2006; Jordan, Riu, Lopez, & del Amo, 2016; Scott, Li, & Davids, 1997). For instance, for this purpose, athletes usually place one or two checkmarks as a running approaching reference: one at the starting point and other at four to six strides from the take-off board.

One question arises: since visually impaired athletes have also performed long jump (e.g., in the Paralympic games), how would they perform the aforementioned adjustments? One could say that the main difference between long jump

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performed by sighted and visually impaired athletes is that the latter depends on additional external information for making decisions, that is, auditory information (exteroceptive) provided by another person. For instance, visually impaired athletes need information provided by a caller (e.g., coach) in order to perform the initial positioning for concentration, the direction of running and transition from running to take-off (Jordán, Padullés, Braz & Robert, 2015; Jordan et al., 2016; Torralba et al., 2017).

Generally, the aid of a caller occurs through verbal (voice) or clap hands auditory stimulus provided throughout running. For this purpose, the caller positions him/herself on a specific local (e.g., in front, back, right or left side of the take-off board), and at a certain running point, the auditory stimulus is modified so that the athlete understands the moment of performing the take-off. There is also the possibility of the verbal command refers to the numerical count (e.g., ten, nine, ... one, zero). In this case, when the count reaches a pre-established value, the athlete performs the take-off. These auditory stimuli were named "transition command".

Interestingly, studies have shown similar approach running patterns for sighted and visually impaired long jump athletes (Jordán et al., 2015, 2016; Theodorou & Skordilis, 2012). Based on recent findings, one could hypothesize that the latter control their performance based on auditory stimuli because of the functional and structural reorganization in cortical areas, changes in the dynamic neuroplastic mechanisms and compensatory sensory processing in the remaining senses constrained by the visual impairment (Collignon et al. 2011; Kupers & Ptito, 2014; Hötting & Röder, 2009; Morin-Parent, Beaumont, Théoret, & Lepage, 2017; Poirier et al., 2006; Vercillo, Tonelli, & Gori, 2018; Voss, Pike, & Zatorre, 2014).

Another important finding related to visual impairment is that the stimulus location influences the individual's ability to deal with auditory stimuli. For instance, Röder et al. (1999) showed that visually impaired individuals had superior localization ability in comparison to sighted individuals when auditory stimuli were provided from the periphery (loudspeakers positioned laterally in relation to the individuals). On the other hand, both visually impaired and sighted individuals obtained similar results when auditory stimuli were centrally located (loudspeakers positioned in front of individuals). Based on that, we hypothesized that the aforementioned diversity of caller's communication behaviors (location and type of transition command) could affect long jump performance by visually impaired athletes. Therefore, this study sought to investigate the effects of location and type of transition command on the long jump performance by visually impaired athletes.

METHOD

A quasi-experimental design characterized this study.

Participants

Eight long jump Paralympics athletes with visual impairment, both male (n = 5) and female (n = 3), with an average age of 26.35 years (± 6.29), and their respective callers (n = 5) took part in this experiment. Just one athlete had acquired visual impairment. All of them were competitors of the T11 class at the national and international championship level and had an average of 10.8 training hours per week. According to the International Paralympic Committee, T11 involves athletes who have a very low visual acuity and/or no light perception. These participants represented 100% of athletes from the state of São Paulo and 47.05% from Brazil. This study was conducted within the guidelines of the American Psychological Association, and the experimental protocol received approval from a local ethics committee at the University of São Paulo (CEP/0518/EEFE/202218).

Task and materials

The task consisted of performing the Paralympic long jump. Two video cameras with 12 megapixels and a frequency of 120 Hz were used (Figure 1): the first was positioned in front of the runway (14 meters) in order to capture the final 15 meters of running and the take-off. This camera also captured the information provided by the caller (i.e., type and moment of command) in each of the conditions. The second camera was positioned in front of the landing location, 14 meters away from the final mark (Figure 1). It captured the images of the long jump's flight and landing phases and the communication of the caller. Furthermore, two cones were used for calibrating the images at a distance of 15 meters from the starting mark to the take-off board, and the other was positioned at the end of the landing area; contrasting powder was used on the lane for recording the take-off point of the jump. We also adopted as standard procedure for data collection the use of an ophthalmic buffer and a sale (mandatory accessory) in order to guaranteed homogeneity among jumpers; and, a computer with the Kinovea 0.8.15 (Polak et al., 2015) software in version 8.15 was used for the video analyses.

Design and procedures

Data collection occurred in the athletes' training environments. Fifteen minutes were given for warm-up to each athlete prior to the experimental trials, during which both athletes and their callers were instructed by the researcher about the caller positions and communication types. An interval of ten minutes occurred between each block of trial for resting and reorganization of both athlete and caller.

Two conditions were experimentally manipulated: (1) caller location and (2) type of caller communication (voice and clap hands). Regarding the first condition, the caller communicated from four different locations: L1 - in front the take-off board; L2 - back to the take-off board; L3 - on the right side of the take-off board; L4 - on the left side of the take-off board. Two long jumps were performed in each location (L1, L2, L3, and L4), under each type of communication (voice and clap hands), totalizing 16 long jumps per athlete. As foregoing, the caller delivered an auditory stimulus through voice or clap hands for the athlete to start and develop the running. At a certain running point, the auditory stimulus was modified so that the athlete perceived the moment of performing the take-off. Such modification occurred by verbalizing a new word, altering the voice tone, the reach of a specific value in a numeric count (voice), or through a different clap hand (clap hands). Concerning inter-rater reliability, a positive correlation between the raters was verified for caller location (r = 0.98) and type of command (r = 0.99) (Levin & Fox, 2004).

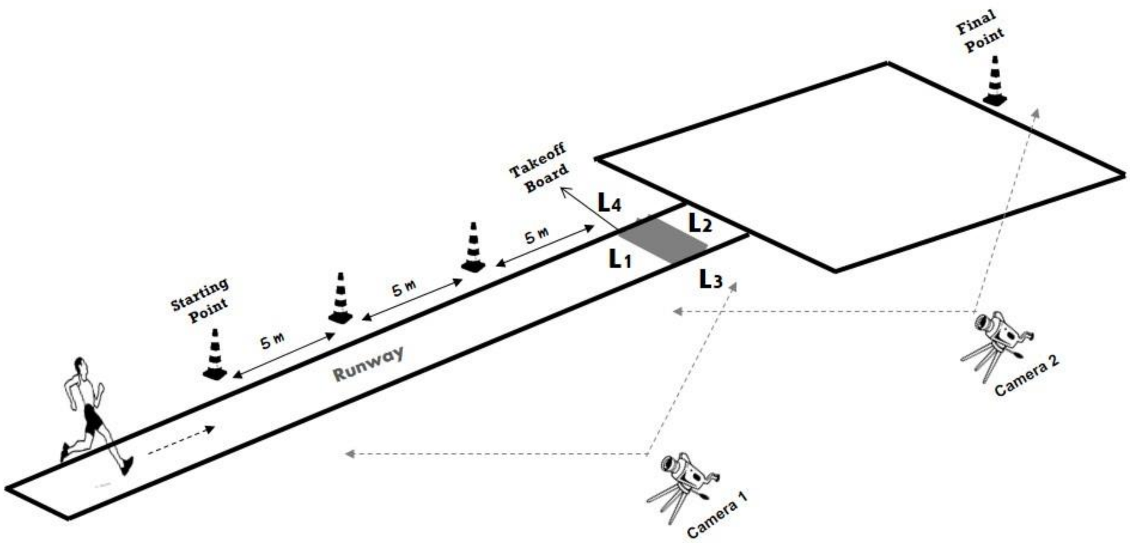

Figure 1. Illustration of the data collection environment involving caller's location (L1 in front the impulsion board; L2 - back to the impulsion board; L3 - on the right side of the impulsion board; L4 - on the left side of the impulsion board), cameras 1 and 2, and initial and final marks of footage (image capture).

Data analysis

From the recorded images, the Kinovea software allowed to calculate the following measures:

(i) long jump performance: it referred to the jumping distance, i.e., the distance between take-off and landing locations. This measure was analysed as the main dependent variable;

(ii) distance between long jump athlete and take-off board in the moment caller provided the transition command;

(iii) running velocity: it referred to temporal rate of displacement (m/s) over 15, 10 and 5 meters before to the take-off board;

(iv) stride size: it was the amplitude of strides (e.g., step length) (m) throughout 15, 10, and 5 meters before to the take-off board.

Firstly, it was analysed the influence of caller location (L1, L2, L3, and L4) and type of command (voice or clap hands) on the long jump performance. Secondly, it was analysed whether long jump performance was influenced by the "moment" of the transition command, that is, the distance between long jump athletes and take-off board in the moment caller provided the transition command. In addition, we analysed if the running velocity affected this distance. For this purpose, such distances were divided according to quartiles as the cut-off points (Altman & Bland, 1994): first quartile (Q1) involved transition commands occurred when athletes were between 0 and 0.61 meters from the take-off board; second quartile (Q2) were those commands provided when athletes were between 0.62 and 0.95 meters from take-off board; third quartile (Q3) referred to the commands provided when athletes were between 0.96 and 2.30 meters from the take-off board; and, fourth quartile (Q4) were commands given when the athletes were between 2.31 and 5.28 meters from the take-off board. Lastly, it was analysed if (i) stride size and running velocity differed throughout running, i.e., 15, 10, and 5 meters from the take-off board, and whether (ii) long jump performance was influenced by the preferred type of transition command and caller's usual positioning.

These analyses were run by an analysis of variance (ANOVA) for repeated measures through STATISTICA® 13.0 software (Stat Soft Inc., Tulsa, USA). Observed significant effects were followed up using $\text{Tukey}_{\text{HSD}}$ post-hoc tests. They were preceded by Shapiro-Wilk's W and Bartlett's tests of normality and homogeneity of variance. For all analyses, the level of significance was set at $p < 0.05$, using STATISTICA® 13.0 software (Stat Soft Inc., Tulsa, USA).

RESULTS

The ANOVAs did not reveal significant effects for main comparisons: caller location [$F_{(3,124)} = 0.13$, $p = 0.99$, $\eta^2 = 0.00$]; type of command [$F_{(1,126)} = 0.07$, p = 0.79, $\eta^2 = 0.00$]. No effects were also revealed for complementary analyses: preferred type of transition command [$F_{(1,126)} = 0{,}18$, p = 0,66, $\eta^2 = 0{,}00$]; caller's usual positioning. [$F_{(3,124)} = 0{,}27$, p = 0,84, $\eta^2 = 0{,}00$].

The ANOVAs revealed significant effects only for moment of transition command vs. running [$F_{(3,124)} = 4.96$, $p = 0.0001$, $\eta^2 = 0.10$], 15 meters vs. 10 meters vs. 5 meters running velocities [$F_{(2,381)} = 146.13$, $p = 0.0001$, $\eta^2 = 0.43$] and stride size 15 meters vs. 10 meters vs. 5 meters [$F_{(2,381)} = 58.80$, $p = 0.04$, $\eta^2 = 0.23$].

Regarding the moment of transition command, the $\text{Tukey}_{\text{HSD}}$ test showed that running velocity in the fourth quartile was inferior to remain quartiles ($p < 0.01$). This means that the transition commands provided when the long jump athletes were furthest from the take-off board were those with them at a slower running velocity than in the distances relative to other quartiles (Figure 2a).

In relation to velocity throughout running, the post-hoc test showed they differed from each other ($p < 0.01$). These results suggest that velocity varied over running, and in the last part (5 meters), it was greater than in the previous meters (Figure 2b). Similar results were revealed for stride size since the post-hoc test showed they differed from each other ($p < 0.01$). In this case, it was observed that stride size varied over running, and in the last running phase (5 meters), it was greater than in the previous meters (Figure 2c).

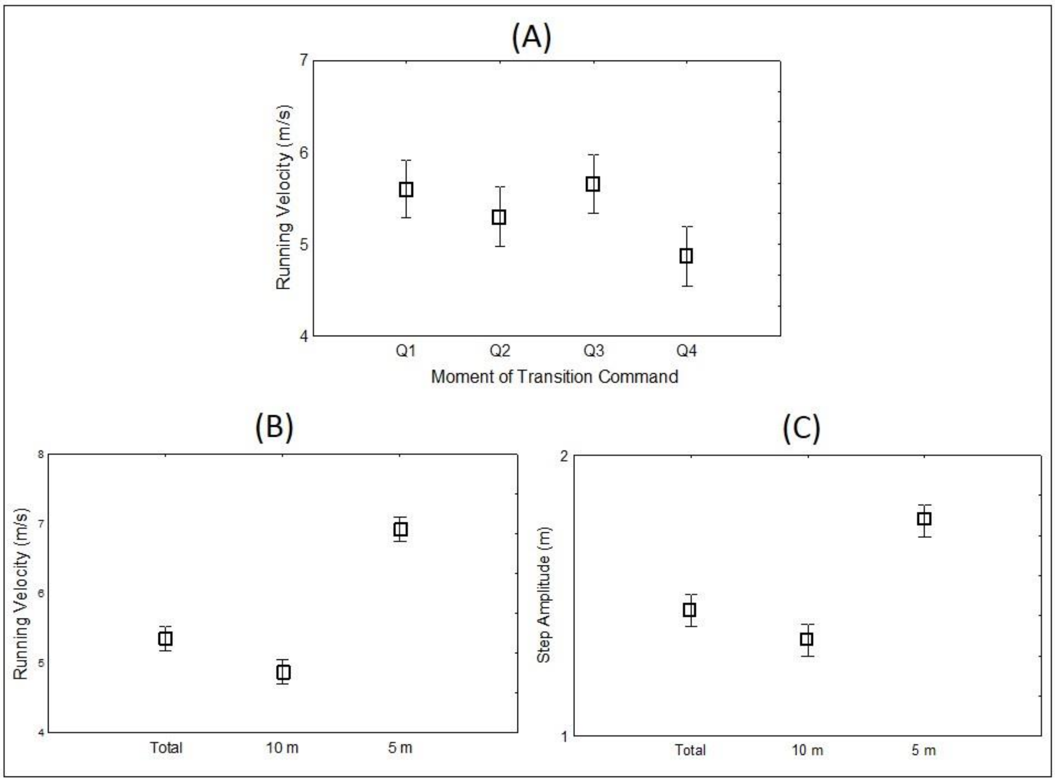

Figure 2. (A) Means of running velocity in the quartiles of the moment of transition command (Q1, Q2, Q3, and Q4); means of running velocity in the 15 (total), 10 and 5 meters before the impulse board; (C) mean of step size in the 15 (total), 10 and 5 meters before the impulse board.

DISCUSSION

This study investigated the effects of transition command related to the caller's location and type of communication on the long jump performance by visually impaired athletes. Results showed that the locations the caller provided such transition commands influenced the long jump performance similarly by visually impaired athletes. They also showed that voice and clap hands commands affected the performance of long jump similarly.

With respect to the location of the caller, although evidence from previous studies pointed out that the locations where auditory stimuli were provided influenced the performance of the visually impaired individuals, it is possible that what was central and peripheral in the study by Roder et al. (1999) was not in the present study. This is because they used the azimuths of 0°, 6°, 12°, and 18° for central positions and 72°, 78°, 84°, and 90° for peripheral locations. This made sense since individuals were in a stationary position of 1.20 meters away from the loudspeakers. However, in our study, the transition commands were supplied throughout the running, from 5.28 meters of distance between the athlete and the take-off board, implying the possibility of azimuth's meaning being continuously modified. Moreover, it may be that changes in directional azimuth may have occurred within a central array since the caller was positioned near (in front, back, right or left side) of the take-off board.

Concerning the type of transition command, it is possible that different auditory stimuli have influenced the long jump performance similarly because the voice and clap hands can have involved the same rhythmic structure as an auditory reference (Magill, 2000). As individuals were experienced athletes, it is also possible that the augmented utilization of the auditory system has resulted in compensatory behavior for different types of sounds (Hötting & Röder, 2009). Alternatively, only the distance of sounds to the athlete is the key-aspect for performance rather than any other variable (Vercillo, Tonelli, & Gori, 2018). However, this warrants further studies.

Regarding the results of the complementary analyzes, it was found that commands provided when the long jump athletes were further from the impulsion board were those with he/she at a slower velocity. In fact, this result was surprising as it was expected that the commands provided at a furthest from the take-off board were the ones at which athletes were at a higher speed. This would allow more time for processing information.

Another interesting result was that the visually impaired athletes changed the running pattern along with the approaching. Specifically, athletes increased the strides amplitude and running velocity in the last five meters in comparison to the previous ten meters, supporting previous findings by Torralba et al. (2017). These changes may have occurred in order to increase the energy to be transferred through impulsion for the flight. As previously described, the transition from running to take-off implies transferring the energy resulting from horizontal velocity into the vertical displacement as part of the flight (Mood, Musker, & Rink, 2011; Schmolinsky, 2006; Tan & Zumerchik, 2000). This result differs in part from those of Lee, Lishman, and Thomson (1982), which showed different initial and final patterns of strides due to increased velocity accompanied by increased variability in the last five strides.

Finally, it was found that the long jump athletes and caller's preferences by the type of transition command and positioning location had the same effects. Based on the explanations of the first results discussed previously, it is possible that the preferred and non-preferred types of command have involved the same rhythmic structure as an auditory reference (Magill, 2000), which was not affected by the location of transition command.

CONCLUSION

The findings of this study allow us to conclude that: (1) clap hands and voice transition commands, and the callers' locations in front, back, right and left side of the take-off board affected similarly the performance of the long jump of visually impaired athletes; (2) transition commands provided when the athletes were furthest from the take-off board were those in which they moved at a slower velocity; (3) in the last five meters athletes increased the steps amplitude and the running velocity compared to the previous ten meters; (4) athletes and callers' preferences for the type of transition command, and positioning location had the same effects. This study provides useful insights into the design of practice tasks in long jump by visually impaired athletes, suggesting that: (1) callers can provide transition command from different locations and of diversified ways, regardless their preferences; (2) transition commands should be provided when athletes are furthest from the take-off board and at a slower velocity; (3) athletes should be advised to increase the steps length and the running velocity when approaching to the take-off board. Future studies could consider the athletes' directional deviation along with the running. Variables of the movement pattern related to the coordination of the body segments (trunk and limbs) could also be analyzed. In addition to this, multisensory processing should be investigated since the auditory processing system could interact with the somatosensory system in order to facilitate action control (Hötting & Röder, 2009).

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