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Research article

Effects of the administration of feedback on performance of the BMX cycling gate start

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Abstract
The aim of the present study was to determine the effect of the administration of external feedback (FB) on the time used to execute the gate start skill in BMX cycling discipline. The sample used was n = 6 riders from the Spanish national team (19.3 ± 2.1 years). An intragroup experimental design with repeated measures was used to compare the evolution of the skill developed by the participants before and after treatment, as well as the degree of retention of the possible learning. The results showed that there were no significant differences between the 2 first pre-test sessions (PRE), nor between any of the other treatment, post-test or re-test sessions (TREAT, POS and RET, respectively). Nevertheless, significant differences were observed between either of the PRE sessions and any of the TREAT, POS or RET sessions ($p \le 0.028$), showing a significant reduction of the time needed to perform this skill after TREAT (1.264 ± 0.045 ms in PRE, 1.047 ± 0.019 ms in POS, and 1.041 ± 0.021 ms in RET). In conclusion, the use of audiovisual FB and cognitive training of the skill can result in a significant improvement in the execution of the gate start in BMX reducing the time to develop the task.

Key words: BMX, cycling, gate start, feedback, motor learning.

Introduction

Bicycle Moto-Cross (BMX) is a cycling discipline that consists of racing across a track with jumps, banked turns and other obstacles over a distance between 300 and 400 metres lasting about 40-45 seconds; the aim of the riders is to reach the finish line in the best possible position. In BMX, a new discipline in the 2008 Beijing Olympics, riders compete in qualifying rounds until the 8 best dispute the final (Zabala et al., 2008; UCI, 2008). The race is started when a mechanized starting gate falls down. The start is a crucial element for success, as it is very important for the rider to be at the front of the race from the very beginning of the competition in order to select the itinerary and to have a certain advantage over opponents that then have to overtake those riders that are at the first positions (Gianikellis et al., 2004; Mateo and Zabala, 2007). Thus the rider needs to apply the efficiency indices of the technical skill of the BMX gate start to achieve a better result in the competition. So, the maximum power generated in a coordinated and synchronized way results in greater distance covered at the start.

In the scientific literature the first work on this subject was developed by Gianikellis et al. (2004). In this study they made a three-dimensional biomechanical analysis at 50 Hz of 3 BMX riders, one of whom took part in the present study. However, that work did not establish the phases of the skill nor give a qualitative explanation; it just dealt with isolated kinematics parameters referring to fundamental positions and velocities of the skill. As so often happens in the interaction between trainers-athletes and biomechanical studies (Lees, 1999), this seems not to help athletes and their coaches with practical applications.

From the field of motor learning it has been proved years ago that the application of an appropriate feedback (FB) can evoke an improvement in the development of a specific sport skill (Janelle et al., 1997; Seat and Wrisberg, 1996). More recently this has been pointed out by authors such as Tzetzis et al. (2008), Ishikura (2008), Chiviakowsky and Wulf (2005, 2007), Tzetzis and Votsis (2006), Konttinen, et al. (2004), Sherwood and Lee (2003) or Baudry et al., (2006), although it has been requested the kind of studies that take into account the real context of training in sport (Chiviakowski and Wulf, 2007) as recently developed by Pérez et al. (2009) in Swimming or Tzetzis et al. (2008) in Badminton. This way, we have to consider the most recent trends in the administration of augmented FB in the improvement of performance of a specific sporting skill. Various studies (Chiviakowski and Wulf, 2002; 2005; 2007; Totsika and Wulf, 2003; Shea and Wulf, 1999; Wulf et al., 1998; 2000; 2002; 2005) argue that external FB focused on the result of the performance (*External-Focus feedback*) results in greater benefits than that focused on aspects relating to the action and that involve focusing attention on specific questions on it by the subject her/himself (*Internal-Focus feedback*). Furthermore, several studies make specific reference to the great importance of the participants' cognitive involvement when learning new skills (Chiviakowski and Wulf, 2005; Guadagnoli and Kohl, 2001; Kimura et al., 2002; Sherwood and Lee, 2003; Wulf et al., 2005; Zabala et al., 2009).

Apart of external FB, as Konttinen et al. (2004) argue, the sources of intrinsic FB are necessary to produce motor learning. In this sense, these sources of learning or optimisation of the skill show themselves in the adaptation made by each subject in accordance with the interpretation of external FB centred on the result, leaving each subject to be responsible and cognitively involved in the self-administering process of FB, as experienced authors of this type of study maintain (Chiviakowski and Wulf, 2005; Sherwood and Lee, 2003; Wulf et al., 2005).

So, the objective of the present study was to test if the administration of self-controlled, positive and exter-

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nal-focus feedback can improve the performance of BMX gate start reducing the time spent on it.

Methods

This intervention study is based in the description of phases in the BMX gate start skill as a simpler technique than biomechanical analysis, using systematic observation of the skill by means of a control list that also details the performance efficiency indices (Mateo and Zabala, 2007). This methodology, although more limited, is much quicker and provides information that is useful to coaches and athletes (Lees, 2002).

Phases of the BMX gate start

Similarly to the starting block start in athletics, BMX riders are prepared for the start by means of a series of prior vocal commands that are recorded in a standard way by a "voice box" system supplemented by starting lights. These commands consist of the following phrases that mark the riders' actions at the different phases (modified from Mateo and Zabala, 2007): 1) *"OK riders, random start. Riders ready"* as a warning that the race is about to be started and that they should stand up. The red light is shown. 2) *"Watch the gate"*. The yellow light is given. 3) The whistle is blown and the green light is shown at the same instant that the gate falls (either under its own weight or mechanically by a hydraulic piston that pushes it forward). Graphically, these phases are shown in Figure 1.

Figure 1A shows the riders waiting, supporting the front wheel against the starting gate not to waste energy, since on some occasions the wait is longer than expected due to organizational reasons (timing, removing an injured rider in the previous heat, etc.).

In Figure 1B the rider stands up and puts his feet in the toe clips of the pedals having heard the command "OK *riders, random start. Riders ready*", and seen the red light as a warning that the race will be started. At that moment the rider is balanced, with both legs semi-flexed, although is still pressing the front wheel against the starting gate to facilitate his balance.

Figure 1C demonstrates how the rider adjusts the crank and the pedals to an angle that will later permit him to exercise the maximum power when he starts to pedal. He watches the gate after hearing "W*atch the gate*", which announces the imminent fall of the gate and the yellow light is shown. In this third phase, the riders pay attention to the stimulus of the fall of the gate to initiate their start, although a few can fix their attention on the light to guide them (some anticipate their start by making a prior counter-movement that has to be synchronised with the fall of the gate although the majority do not make this countermovement as the fall of the gate is not fixed in time). They approach their movement as closely as possible to the gate not to lose time. If the rider goes forward too soon and hits the gate, there is the possibility of falling and so losing almost all options in the race.

Figure 1D shows the commencement of the forward movement, where the rider pedals as energetically as possible to reach maximum power. At the same time his arms help him to move his trunk forward to avoid the front axis of the bicycle lifting up excessively, since this would make him lose his balance and it would become difficult to push the pedals as powerful as possible to start faster.

Efficiency indices of the BMX gate start

The efficiency indices of the skill were determined through video observation of numerous BMX gate starts made in international competitions, to establish the following criteria (based in Izquierdo and Echeverría, 2004):

1. Standing up to wait at the correct moment (approximately 2 s before.).
2. Adjusting the pedals to the starting angle in sufficient time (3-5 s).
3. Adjusting the feet to the correct angle (90±4.5º) to transmit the maximum power possible to the pedals.
4. Making the counter-movement of the legs and trunk prior to the fall of the gate (optional).
5. Adjusting the start of the forward movement to the fall of the gate, preferably almost scraping it (≤5 cm).
6. Making a forward movement of the trunk to avoid the front wheel lifting up after beginning the start.
7. Adjusting the front wheel to the ground in the first pedalling actions (≤10 cm).
8. Continuing the action by pedalling as powerful as possible but under control and balance to cover as much distance as possible in the less time.

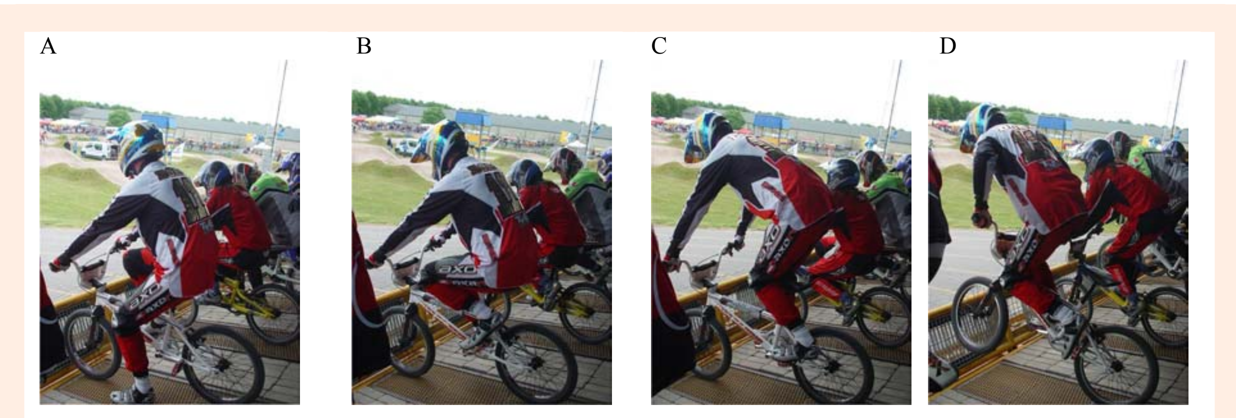

Figure 1. A) Rider waiting, B) beginning the preparation for the start, C) end of preparation for the start, D) beginning of the start.

Participants

Six male BMX riders members of the Spanish national team completed the sample of this study (age 19.3 ± 2.1 years old, height 1.75 ± 0.05 m, weight 75.1 ± 5.3 kg, body mass index of 21.1 ± 2.2 kg·m^{-2}, body fat estimated by Faulkner's equation 11.2 ± 2.1%). All the participants had previous experience in starts with mechanized gates as employed in this study. Furthermore, the participants had received no specific FB on their performance in this type of skill previously. The riders gave their full written consent and cooperation throughout, although for the purposes of the experiment they were not given precise details of the research.

Design

An intra-group design with repeated measures was used in this research. The aim was to compare the development of the efficiency of the sample's action before (PRE) and after (POS) the treatment (TREAT) through the administration of FB, as well as the degree of retention of possible learning (RET).

Variables and type of feedback

The independent variable of the present study was centred on a specific programme of administering FB, made up of 1) a session of audiovisual FB to analyze the pre-test performances (PRE) recorded on video, using a control list for its analysis, and 2) two practice sessions (TREAT) in which the participants tried to apply the conclusions reached in the previous analysis session while external FB was administered.

The main dependent variable was the time taken to cover a fixed distance of 4.5 metres from the start. This distance was considered the best to complete the previously described phases of the skill and also to provide a greater distance of an external focus of attention to enhance learning as suggested by McNevin et al. (2003). Apart, the performance of each technical action was observed to judge it qualitatively according to the different efficiency indices delimited and observed on the control list, highlighting the errors that the participants committed most commonly.

So, the treatment was based a) in the analyses of the firsts performances on video according to the described efficiency indices (theoretical session) and b) on the administration of two types of augmented FB during practical sessions: 1) knowledge of results of the performance, by informing the riders of the time employed in carrying out the skill, 2) knowledge of performance through the use of descriptive and evaluative FB after performing the skill (based in the works developed by Wulf et al. -2005- and Chiviakowski and Wulf -2005-), and 3) Positive FB added to the Knowledge of results just after good trials.

Knowledge of results and knowledge of performance FB were administered just when the subjects asked for them, so they could control the type and quantity of FB (33 ± 2% of the executions and mainly related to better executions). Positive FB with knowledge of results - i.e. "well done, 10.150 seconds"- were provided by the observer after good trials (as recommended by Chiviakowsky and Wulf, 2007) when the execution was well developed according to efficiency indices and the time spent on the task was very close (≤50 ms) or lower than the previous best repetition (50 ± 4% of the repetitions). Most of the requested FB by the subjects matched up with the positive plus knowledge of results FB after good trials. Also, researchers pointed out to the subjects prior to the treatment sessions to focus their attention in the line of 4.5 m to increase the distance between the body and the action as suggested by McNevin et al. (2003).

Material

The study was made in the covered track of the world cycling centre of the Union Cycliste Internationale (UCI) in Aigle (Switzerland). A mechanised gate (*Pro-Gate*®) integrating a synchronized photoelectric cell time measurement was used for the starts and to record the time recorded from the moment in which the gate began to fall to a point situated at 4.5 m from the start line (Figure 2). This enabled to record the time of the action of the start itself and the continuation phase (first pedalling actions). Session performances were recorded on audiovisual equipment with a video camera model *Panasonic NV DS68.* A Sony audio recorder, model TCM-313, was used to record the interviews to the riders at the end of the study. A specific sheet was utilized to register the riders' performance according to the previously determined efficiency indices. The computer software *Microsoft Office* 2007 and SPSS 14.0 were used to analyze the data.

Figure 2. Detail of automated integrated and synchronized system of the starting gate, photoelectric cells and video recording.

Procedure

Prior to the study numerous BMX gate starts were recorded and observed from international competitions to determine the efficiency indices and to design the control list used in this research (Mateo and Zabala, 2007).

This study included 8 practice sessions of which two corresponded to the PRE situation, the following two to TREAT (although also a videotape TREAT session was performed after the second PRE session to analyse all these previous executions as part of treatment and before the two TREAT practice sessions), the next two were

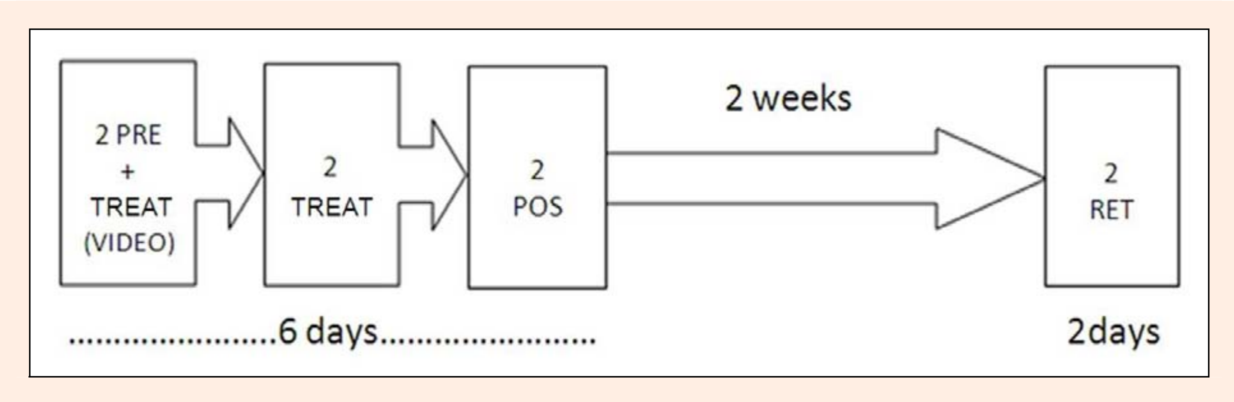

Figure 3. Study scheme showing the chronological sequence of the sessions.

dedicated to POS and the last two to measurement of the possible retention of learning (RET) (Figure 3). Each rider performed the action 20 times in each session recovering 3 minutes between them, and there was one session per day during successive days coinciding with a training camp except for the RET sessions that were carried out two weeks after POS sessions. The 10 best performances of each subject in each session were studied.

In the PRE situation the participants performed the actions in they way that they usually did without receiving any type of FB, so establishing a base line. The riders did not know that an exhaustive study of their actions was carrying out and to maintain this situation the time of each performance was noted down without their knowledge. Subsequently, the same day after finishing the second PRE session, the video recording of the performances was analysed to determine the key aspects in which the subject could improve, comparing the times achieved and analysing the actions in accordance with the efficiency indices previously established. In this way, relevant comments were made about each rider, they themselves contributing their impressions about their own performance (this was the first TREAT session, although theoretical). In the following practical TREAT sessions they then tried to improve their performance by adjusting the action according to the efficiency indices, trying to reduce the time employed in covering the pre-established distance. The subjects were encouraged to focus their attention on the line of 4.5 m after the location of the gate and previously described FB was administered individually.

During the POS and RET sessions the same protocol was carried out as during the PRE practice sessions.

For the statistical analysis of the time taken in performing the skill by the 6 participants and in order to determine if any statistically significant difference ($p \leq 0.05$) existed between the 8 sessions made by each rider, a repeated measures ANOVA was used. Complementary, from a qualitative perspective and based in the previously described efficiency indices, an analyses of the trials developed in PRE sessions was developed to extract a descriptive view of the most common errors observed (in %). Also individual interviews to the participants were carried out after the TREAT sessions to check if riders could describe the main key points related to the skill.

Results

Quantative analysis of the performance

In Table 1 it can observed how the average time for the 10 best performances of each subject changed during PRE, TREAT, POS and RET sessions, so that in all the cases the time spent for the task was reduced significantly between PRE sessions and the rest. Also, at the end of table 1 the values for the group are presented, showing that the time was significantly reduced comparing PRE sessions with the rest.

The average values for the group are represented in Figure 4, so that the changes as a group are evident comparing PRE sessions with the rest. Statistical analysis revealed no significant differences between the first two PRE sessions and between any of the TREAT, POS, and RET sessions, respectively. However, significant differences were observed between either of the PRE sessions and any of the other sessions ($p \leq 0.028$ in all cases), showing an evident reduction of time used for the task. There was also a reduction in the variability of the performances in terms of Standard Deviation (SD) for the group (from 0.045 in PRE, 0.018 in POS, and 0.019 in RET). Equally remarkable is that two weeks later the participants maintained an adequate level of learning retention maintaining the average value for of time spent for the task.

Table 1. The average time (ms) of the 10 best performances made by each subject in PRE, TREAT, POS, and RET sessions. Data are means (±SD).

	PRE 1	PRE 2	TREAT 1	TREAT 2	POS 1	POS 2	RET 1	RET 2
S1	1.29 (.03)	1.27 (.04)	1.19 (.03)	1.17 (.03)	1.15 (.03)	1.15 (.02)	1.18 (.02)	1.14 (.02)
S2	1.25 (.04)	1.24 (.03)	1.10 (.04)	1.09 (.02)	1.06 (.02)	1.06 (.02)	1.05 (.02)	1.07 (.02)
S3	1.15 (.03)	1.15 (.03)	1.02 (.04)	1.00 (.02)	0.98 (.01)	.99 (.02)	.95 (.02)	.99 (.02)
S4	1.32 (.05)	1.30 (.04)	1.10 (.05)	1.09 (.03)	1.05 (.01)	1.06 (.02)	1.05 (.02)	1.05 (.01)
S5	1.29 (.06)	1.29 (.06)	1.01 (.07)	1.00 (.02)	0.98 (.01)	.98 (.02)	1.00 (.02)	.95 (.02)
S6	1.31 (.07)	1.32 (.06)	1.09 (.08)	1.06 (.03)	1.05 (.03)	1.05 (.02)	1.03 (.02)	1.05 (.02)
Group	1.27 (.05)	1.26 (.05)	1.08 (.05)	1.07 (.03)	1.05 (.02)	1.05 (.02)	1.04 (.02)	1.04 (.02)

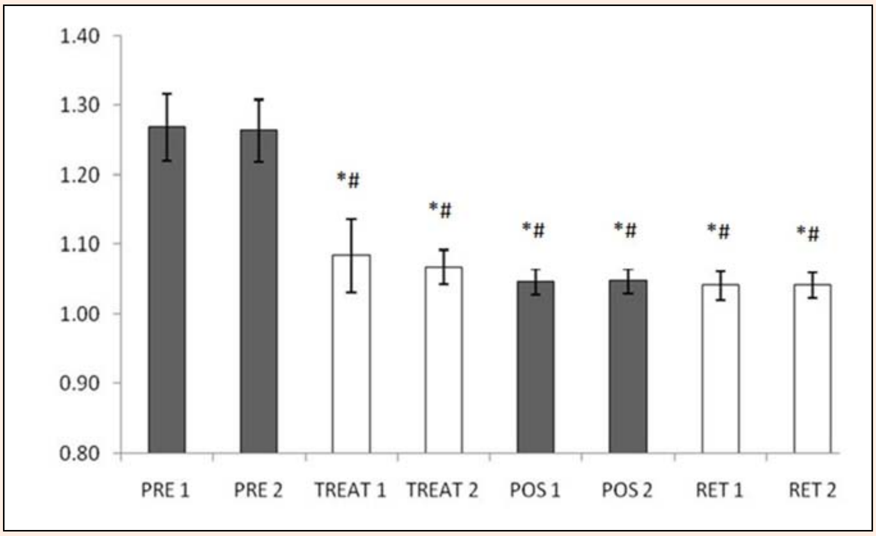

Figure 4. Mean values ± SD of time (ms) to cover 4.5 m in the two PRE, TREAT, POS, and RET sessions.
*# Significant differences ($p \leq 0.05$) between this session and PRE 1 (*) and PRE 2 (#), respectively.

Qualitative Analysis of the executed skill

From the control list, based on the predetermined efficiency indices, the errors most commonly observed by the riders when watching the videos and in the TREAT sessions were extracted:

1. Not making the forward movement of the trunk to prevent the elevation of the front wheel (83.3 % of all cases).

2. Not adjusting the front wheel to the ground (≤20 cm) in the initial forward movement (81.2 % of cases). Possibly due to the previous error 1.

3. Not adjusting the beginning of the start to the fall of the gate (52.2 % of cases).

4. Not continuing the initial pedalling in a fast but controlled way (43.23 % of cases). Possibly due to previous error 1 and/or error 2.

The following less important and less frequent errors were observed such as:

1. Not putting the toe clips at the ideal angle to make the greatest possible force on the pedals (3.2 % of cases).

2. Not preparing the task in sufficient time so the rider can be concentrated and ready to perform the skill with control (2.1 % of cases).

The interviews with the riders revealed the points of the BMX gate start skill that they found most difficult:

1. Adjusting to the gate. This refers to the maximum synchronization between the rider's starting movement and the fall of the gate, so that the rider goes forward almost scraping it at the greatest possible velocity. This idea is based on illuminating comments such as, *"...I could find no way to adjust my start to the fall of the gate; I was always late even when I thought I had strived for it as hard as I could. Then you realise when you see the video that you could have anticipated it much more. When you see it on the video it is not at all like you think it is when performing it"*. Here we must point out that this was the first time the participants had seen themselves on the video doing this action.

2. To keep the front wheel as close as possible to the ground at the same time as pedalling at maximum speed, although in a good start the front wheel always rises up a little, not touching the ground in the first few metres. This is based on typical statements like, *"...in the start all you think about is pedalling all you can, without taking into account that if you have the wheel off the ground pedalling like crazy you won't advance as much as if you have the wheel closer to the ground; you think you are going faster but the milliseconds are ticking away. If you start more controlled the time is lower although at first you feel the contrary"*.

Discussion

In this study we found out that the participants reduced the time spent on developing the gate start in BMX after TREAT (1.264 ± 0.045 ms in PRE, 1.047 ± 0.019 ms in POS, and 1.041 ± 0.021 ms in RET). So, the use of audiovisual FB and cognitive training of the skill can result in a significant improvement in the execution of the gate start in BMX reducing the time to develop the task. The reduction of about 200 ms in this skill means a much better start in competitions. The gain of 200 ms in the practice means that a rider can put the elbow in front of the opponents' that are near him. In fact, the participants of this study improved their results in the following international competitions mainly due to the improvement in their start position, and this intervention was seen by them as a successful specific training. Other studies have pointed out the improvement when performing a task, although data is not comparable. In example, non specific actions as timing a task (Chiviakowsky and Wulf, 2005), throwing an object at a target (Chiviakowsky and Wulf, 2007), or sport actions as badminton skills (Tzetzis et al., 2008) or swimming while receiving different kinds of FB (Pérez et al., 2009).

Totsika and Wulf (2003) studied the influence of external and internal foci of attention learning to ride a Pedalo®. The Pedalo® involves coordinating the entire body and, primarily, keeping balance while subjects have to pedal in two platforms in a single device in a position similar to walking. A stopwatch was used to measure movement time and the time to ride a given distance of 7 m. Twenty two subjects with no prior experience were assigned to external (n = 11) or internal (n = 11) focus of attention to learn the skill. The time needed to execute the task decreased across practice trials. Always the external focus of attention group got the best results. As the task was new for the participants, the reduction in time was very high in this non-specific sport skill, from 28 seconds to 15 seconds after 10 practices and to 12 seconds after 20 practices. So a reduction of 13 and 3 seconds were showed after 10 and 20 practices respectively. Although the reduction in time at the beginning was spectacular, this reduction was much lower across practices, being similar in the last practices. In our study the task was very well know and widely practiced in training and competitions by the participants, and instead 7 m we measured 4.5 m. Although the performance was stable at the beginning in our study, after the TREAT a reduction of 200 ms was reached. This reduction is not comparable with the one reported by Totsika and Wulf (2003) as participants in their study were university students (elite athletes in our research) and they were learning a new skill. Also, at the latest repetitions their performances were almost regularized and stable. Finally 200 ms can be an insignificant reduction of time for some tasks, subjects or recreational contexts, while for our sample this reduction of time means giving the possibility for success in elite competitions.

The results obtained in this study concur with the propositions of Wulf et al. (2002, 2005), who argue that induction to a focus of external attention can produce motor learning in participants. By focusing the subject's attention on the effect of the movement greater use of the subject's control processes can be encouraged. Even authors such as McNevin et al. (2003) argue that a greater distance to the external focus of attention helps to improve learning as it develops discrimination between the effect of the movement and the corporal movements that produce it, so that focusing on more distant effects result in enhanced learning by promoting the utilization of more natural control mechanisms. Hence in the present study the cut-off point of the photoelectric cell was set at 4.5 m from the point where the gate begins to fall, since these initial metres, being part of the effect of the start itself, can contribute in the sense mentioned earlier

The newer theory of administration of FB differs from the single conception that the trainer must provide information about postural imbalances that the athlete has then to interiorise (FB centred on the internal aspect), to make the corrections automatically. So, the type of FB centred on the execution and not on its result can be useful in the early stages of learning motor patterns, but has shown itself to be much less efficient both in novices and experts when improving a specific sporting skill. Furthermore, it is argued that the administration of FB centred on the result produces improvements that are maintained equally as well as those acquired by other procedures. Moreover, as shown later in the qualitative analysis of the results, the participants show that they believe they have improved in this sense. This conception goes against the idea that asserts that the manipulations of FB are more effective when they permit the subject to be aware of his/her corporal movements, as stated by Salmoni et al. (1984), Schmidt (1991) or Schmidt and Lee (1999).

On the other hand, it has been argued that the systematic use of FB on execution after every repetition can even be harmful (Konttinen et al., 2004), suggesting that administration at regular intervals of various executions can be more desirable (Wulf et al., 2002). In a recent study, Ishikura (2008) examined the effects of reduced relative frequency of knowledge of results on learning to putt in golf. Participants putted a golf ball assigned in one of two groups (100% of knowledge of results or 33% of Knowledge of results). After the treatment the 100% group showed in the tests a larger Constant Error than the of 33% group. These results also supported that reduced relative frequency of knowledge of results was effective in learning the accuracy of the golf putt. In our case, FB on the result or performance obtained could be administered to the participants after each execution, although the subject himself decided so after each execution -being reinforced by the observer if appropriate-. In this way the participants played a responsible and active part in their learning, following the theory according to which the participants have to self-regulate their FB and make a cognitive effort in the process (Chiviakovsky and Wulf, 2007; Sherwood and Lee, 2003). The value for the asked FB in our study was 33±2%, almost the same as successfully administered by Ishikura et al. (2008) of 33%. The difference is that in our study the participants asked for the FB while in Ishikura's et al. study this value was previously decided and given by the researchers. By following an insistent pattern of FB, participants may become dependent on it, acting against the intrinsic processes of post-response FB (Wulf et al., 2002). On the other hand, self-controlled FB seems to be more effective when the learner can make a decision about receiving FB after the executions, and this can benefit learning as they can decide about FB based on the performance of a specific trial; and this was taken into account in our intervention.

Also, FB after good trials was administered based in the evidences that support that learners prefer to receive FB after they believe they had a "good" rather than a "poor" trial (Chiviakowsky and Wulf, 2007). This was made by the observer based on the evidence of both the time spent in the execution as well as the adequation to the technical indices. Chiviakovsky and Wulf (2007) found that learning was facilitated if FB was provided after good rather than poor trials, suggesting the evidence for a motivational function of FB. Mouratidis et al (2008) also found that motivational FB can sustain the motivational model inducing higher levels of vitality and greater intentions to participate, through the mediation of autonomous motivation. In our study the FB after good trials was provided when appropriate in 50 ± 4% of the occasions, being this % a cording to the previously and successfully administered by Chiviakowsky and Wulf (2007) of 50% of the trials. This % was controlled by the observer trying to be as close as possible to this value.

Apart of the reduction of the time spent for the task that means an evident improvement in performance, in our study a reduction in the variability of the performances was shown in terms of SD, suggesting that the participants were assimilating new motor adaptations or their performance could be more stable and consistent. The SD varied from 0.045 in PRE, 0.018 in POS, and 0.019 in RET, so taking into account that the 10 best trials of 20 were studied, this can be seen as a more stable performance of the subjects.

Complementary to the practical sessions, the addition of the video session was in agreement with the idea supported by Ford et al. (2007) that concluded that performers at high levels of skill use the visual consequences of the action to plan and execute an action. This supports the idea that it is important to athletes to have a clear external view of their performance. In fact, Holmes and Calmels (2008) suggest that imagery and observation are multicomponential, involving individual difference characteristics that modify the processes, and proposing observation-based approaches to offer more valid and effective techniques in sport psychology and motor control. In this sense, Bennet et al. (1999) argue that the importance athletes place on practice agrees with the statement made by that the variation of visual information can foster exploration during practice and makes an important teaching contribution to motor learning in sport. Here we must point out that this was the first time the participants had seen themselves on the video doing this action specifically. On the basis of the data obtained watching the video and subsequently analysing it, the participants adjusted those aspects that did not achieve consistently at the beginning and they were then able to apply them (as shown in the efficiency indices set out in Table 1). Audiovisual FB in the first instance resulted in the participants themselves making certain changes in their performances which were rapidly assimilated in a single session (although the time spent and the SD was higher than in the rest of the sessions being theses results the average for the 10 best times of 20 repetitions) while at the same time FB was administered to the participants on the result achieved. Some technical adjustments were observed related to better times in carrying out the skill. In addition to these improvements, they showed consistent improvement - times spent in the skill- two weeks later without practising the skill systematically.

Conclusion

According to the results, it appears that a single session of audiovisual FB -developed through watching and analysing images of athletes' own trials- together with the application of practice sessions of self controlled and positive FB with external focus of attention can produce a significant improvement in the performance of the gate start in BMX.

The participants detected changes in certain of the technical efficiency indices that, subjectively, they related to their own improvement in performance. To train with this specific methodology enabled the subjects to observe the efficiency indices so they could relate the time spent on the task with their own performances.

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Key points

- This work provides a practical application of many studies developed around teaching-learning technique in sport. In those studies this kind of applications were suggested as necessary.
- All the recent theories are applied in the real sport context, and using elite athletes.
- A successful program is proposed to be used by coaches and athletes just following a few simple guidelines, and this can be a really useful tool to follow.

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