

Increasing the dive-length of swimmers through personalised targets

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In swimming races, a key component for a good start dive is the dive's length. Swimmers trying to improve their dive length need to make specific reference points in order to evaluate it and to understand where to aim for in order to improve it. Often coaches suggest pointing at available landmarks of the swimming pool such as the backstroke indicator, i.e., five meters from the starting wall. However, this distance is unreachable (i.e., unaffordable) for the majority of swimmers and therefore may frustrate the need of achievement of the swimmer. Here, we hypothesized that a personalised target placed just ahead of the impact point of the swimmer with the water (i.e., a difficult but not impossible target) would be effective in lengthening the dive. Eighteen amateur swimmers performed two pre-training dives. They were then divided into three groups and asked to perform ten training dives with either the personalised target, a target appended at the backstroke indicator or no target. The training was followed by one post-training dive performed without a target in order to evaluate any improvements made. Results indicated that the personalised-target group had the greatest improvement, proposing a method for improving dive-length and stressing the importance of affordances and motivational factors when training swimmers.

KEY WORDS: Affordance, Attention Dive, Goal setting, Focus of Affordance, Swimming, Training.

It is well established that sport performance is usually improved through repeated practice. However, in recent years several studies have shown that other methods focused on psychological mechanisms can be just as effective in enhancing the outcome of athletic performance. For example, ingesting a placebo drink improves running performance (Hurst, Board, & Robets, 2013); visual imagery involving overcoming challenges may increase the confidence and performance of golf players (Hammond, Gregg, Hrycaiko, Mac-

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tavish, & Leslie-Toogood, 2012); increasing positive affect favours sport performance (McCarthy, 2011), inducing an external focus of attention in golf players improves the precision of their pitch shot (Bell & Hardy, 2009) or suggesting a range of relaxation, imagery, and self-talk strategies to soccer mid-fielders before the match increases their precision in passing the ball during the match (Thelwell, Greenlees, & Weston, 2006). In the present study we investigated whether a target could lengthen the start dive of a group of amateur swimmers.

The start dive is one of the fundamental moments in swimming races, particularly the shortest ones such as the 50 m (Vantorre, Seifert, Fernandes, Boas, & Chollet, 2010). There are two main forces that the swimmer must take into account for a good start dive. The first is the vertical force that moves the swimmer up against gravity. The second is the horizontal force, which is responsible for moving the swimmer forward. The optimal dive requires moving the swimmer as far as possible (i.e., horizontally, the air has a drag force ~400 times lower than water) but, at the same time, preserving enough energy to enter the water at a good angle for the subsequent underwater phase (e.g., Vantorre et al., 2010). Interestingly, the dive length is one of the factors explaining the performance of the swimmer at the 15 m distance (e.g., Seifert et al., 2010).

When the swimmer wants to lengthen the horizontal component of the dive, s/he needs to make reference points in order to objectively evaluate the length of the dive and to understand where to aim at in order to improve it. One possibility is that of using the existing landmarks of the standard swimming pools. Standard swimming pools mark two distances, two and five meters from the starting wall. The end of the black “T” at the bottom of the swimming pool marks two meters from the starting wall whereas the backstroke indicators and the lane ropes mark the five meters distance (see Figure 1). In practice, the swimmer attempting to improve dive length may try to point at the five meters distance suggested by the backstroke indicators. The two meters distance, in contrast, seems of no use because even amateur swimmers are able to dive over this length (see results section). Therefore, in actual training practice, the backstroke indicator is often the chosen target. Before the study, we contacted several coaches, including coaches of master swimming teams and one coach of the Italian national swimming team and they suggest athletes to point at the backstroke indicator in order to improve the dive’s length. Here, we argued whether aiming at a target can be more effective than simple repeated practice in improving dive length. In addition, we argued whether the backstroke indicator is an effective target (at least for all swimmers) and investigated whether a personalised target (i.e., adjusted to

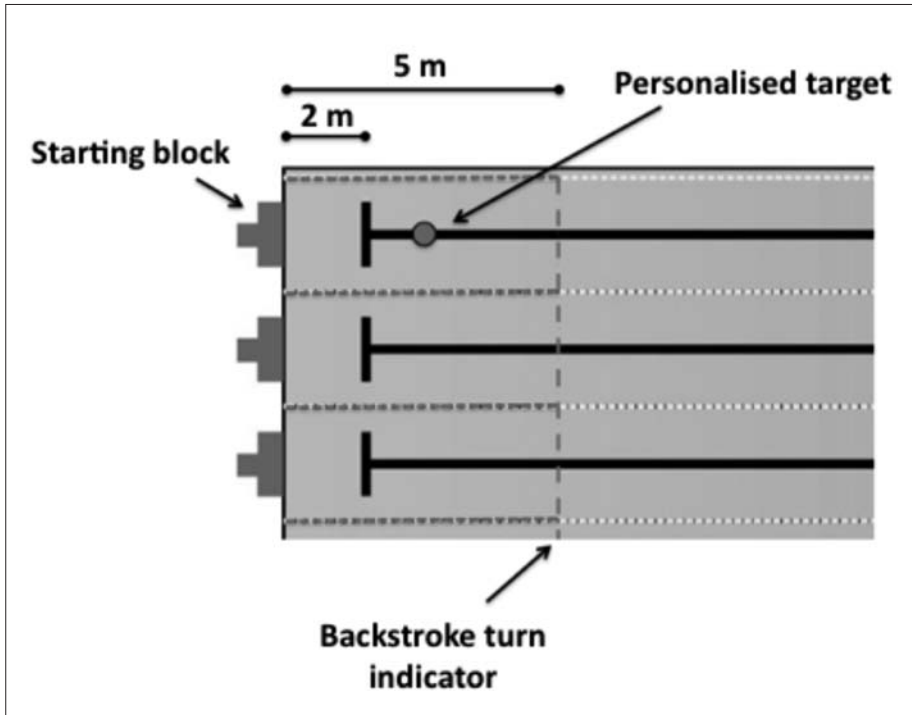


Fig. 1 - Schematic representation of the lengths marked in the standard swimming pools together with one of the possible distances marked with the personalised target used in the study.

the swimmer's dive length) can be even more effective in improving the dive length.

The available estimates of the dive-length of elite swimmers, such as Junior European Champions, the finalist of four Olympic Games, and two bronze medallists at the World Championships, range from 3.0 m to 4.4 m with an average dive length of 3.8 m (Seifert et al., 2010). The dive length of amateur swimmers is shorter than this estimate and therefore, aiming for the backstroke indicator (i.e., five meters from the starting wall) may not be a good strategy to improve the dive length of these swimmers. Since this five meters target is impossible to reach for most swimmers, aiming for this target will likely frustrate the need of competence (Harter, 1978) and achievement (Atkinson, 1964) of the swimmer. According to the goal setting theory (Locke & Latham, 1990; 2006; 2007) people perform better and are more

motivated when a specific, personal, challenging but yet realistic goal is set. In other words, when a task seems beyond reach (e.g., pointing at the backstroke indicators) it does not trigger the motivation of a person (Moè, 2009), since it does not support the idea of effort attribution (e.g., Moè & Pazzaglia, 2010) and commitment. For this reason, here we investigated the effects of placing a target 40-cm ahead of where the swimmer usually enters the water (personalised target). This distance (i.e., 40 cm) was selected on the basis of several pilot observations made before the study. In addition, the personalised target could possibly afford a catching behaviour (Fajen, Riley, & Turvey, 2009).

In the current study, three groups of amateur swimmers trained to improve their dive length with either the personalised target, with a target appended at the backstroke indicator (standard target) and with simple repeated practice but no target (control group). Overall, we expected the personalised target group and the standard target group to show a greater improvement than the control group due to the lack of any target in the control condition. In addition, we expected the personalised target group to show a greater improvement than the standard target group because of the difficult, challenging (but not impossible) distance of the target.

Method

PARTICIPANTS

Eighteen amateur swimmers (10 women and eight men, $M_{\text{age}} = 25.13$ years, age range 20-40 years, height range 152-180 cm) participated in the study. They all signed an informed consent before their participation. At the time of recruitment, all participants were undertaking swimming classes twice a week at the local swimming pool. They covered all the swimming styles (i.e., front-crawl, backstroke, breaststroke, and butterfly), dived reasonably well and could swim a 50 m front-crawl between ~35 s and ~42 s. The participants were divided in three groups (personalised group, standard group and control group) that were matched as best as possible for sex, height, and swimming skills (see Table I).

APPARATUS

All dives performed in the experiment were filmed with a fixed camera JVC Everio GZ-HM400, capturing 60 frames per second with a resolution of 1920 by 1080 pixels. The camera was placed 2.5 m from the starting block and alongside the pool lanes where the dives were performed. A set of marks (one every 10 cm) placed along the edge of the swimming pool (dives were performed in lane 1) enabled the measurement of the dive-length.

TABLE I
Mean Age, Height And, Pre-Training Dive-Length of The Groups (Standard Deviations In Parentheses)

Group	Age (years)	Height (cm)	Pre-training dive-length (cm)
Personalised target (four females, two males)	22.5 (1.4)	169 (8)	264 (38)
Standard target (three females, three males)	27.1 (6.2)	166 (8)	256 (22)
Repeated practice (three females, three males)	25.8 (7.0)	170 (8)	262 (26)

PROCEDURE

Personalised, standard and control groups participated in the experiment on different days. Each group performed 13 dives in one experimental session: two pre-training dives, followed by ten training dives and by one post-training dive. All groups performed pre-training and post-training dives with no target and were encouraged to dive as far as possible. They were asked to start the dive normally (i.e., head in) and to dive as they would dive for the start of a free-style (i.e., crawl) swim. The pre-training dives were preceded by a 10 min warm-up swimming session. The training dives and the post-training dive were separated by 10 min of free swimming.

Each group underwent a different training. The standard target group could see a target (a 25 cm diameter blue polystyrene disc) appended to the backstroke turn indicators. The target was suspended 0.3 m above the surface of the water and was visible throughout the training session. Swimmers were instructed to point at the target in the flying phase of the dive in order to dive as far as possible. In the personalised target group, the target was placed on the water surface. For each swimmer, the target was positioned about 40 cm ahead of the point where the participant touched the water in the pre-training dives. In other words, if the participant dove 2.5 m far from the starting wall in the pre-training dives, the target for this participant in the training session was placed 2.9 m away from the starting wall. In order to keep the target still, it was attached to the swimming pool lane ropes with a rubber band. Finally, the swimmers of the control group were simply asked to dive as far as possible.

At the end of the experiment, the video of each dive was evaluated in order to estimate the dive lengths. In order to gather an unbiased estimate, this calculation was carried out by an individual unaware of the hypothesis driving the experiment. The dive-length was calculated as the distance between the starting wall of the swimming pool and the point where the participant touched the water with his/her hands.

Results

We conducted a preliminary one-way analysis of variance on the average length of the pre-training dives in order to understand whether the dive-length of the groups differed. The dive-lengths of the three groups were not different: $F(2, 15)=0.32$, $p=.73$, $\eta_p^2=.01$. We then calculated the Dive-Length

Improvement (DLI) by subtracting, separately for each participant, the length of the post-training dive from the average length of the pre-training dives. Ten Training Dive-Length Improvements (TDLI) were also calculated by subtracting, separately for each participant and training dive, the length of the training dive from the average length of the pre-training dives (see Figure 2).

A one way analysis of variance with the swimmer's height [footnote 1] as covariate revealed a main effect of training condition on DLIs, $F(2, 14)=31.34$, $p<.001$, $\eta_p^2=.82$. Post-hoc Tukey comparisons showed that the DLIs of the personalised target group were larger than both those of the standard target group and the repeated practice group (all $ps<.001$) and that those of the standard target group were larger than those of the repeated practice group (all $ps<.05$).

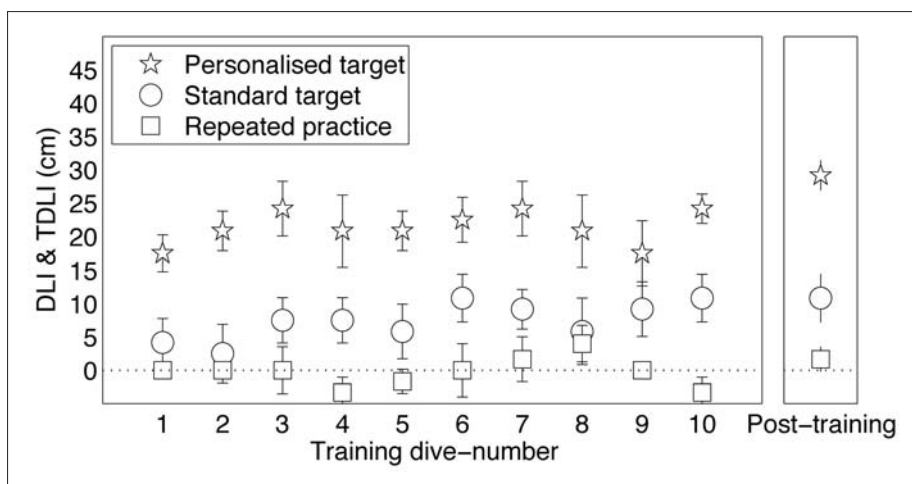


Fig. 2 - Training dive-length improvement (TDLI) as a function of the training dive number (left graph) and dive-length improvement (DLI) in the post-training dive (right graph). In both graphs the horizontal dotted line represents zero (i.e., no improvement) and the vertical bars represent ± 1 standard error of the mean.

¹ In preliminary statistical analysis we observed that the dive-length and the height of the swimmer were highly correlated, $r(18)=.734$, $p=.001$.² We do not agree with the term unreflective action for this type of phenomenon. See Hutto & Sánchez-García (2014) for a discussion on this issue.

Successively, we investigated whether DLIs were greater than zero, i.e., whether improvement was greater than zero, with six Bonferroni corrected one sample t-tests. Only the personalised target group revealed significant improvements, $t(5) > 14.5$, $p < .001$, and $d > 5.9$, whereas the other groups did not: standard target $t(5) \leq 3.31$, $p \geq .063$, $d \leq 1.35$, repeated practice $t(5) < 1$, $p > .05$, $d \leq 0.40$.

We assessed the robustness of the results by analysing the TDLIs of the three groups across the 10 training dives. A 3-groups by 10-training dives analysis of variance on TDLIs with height as covariate confirmed the main effect of group, $F(2, 14) = 25.34$, $p < .001$, $\eta_p^2 = .78$, no effect of training dive-number, $F(9, 126) = 0.51$, $p > .05$, $\eta_p^2 = .03$ and no significant interaction, $F(18, 126) = 0.80$, $p > .05$, $\eta_p^2 = .10$. The absence of an interaction suggests that the improvement in the personalised group was immediate (i.e., starting from the first training dive) and steady across all training dives (see Figure 2).

Discussion

In the current study we investigated whether it is possible to improve the dive length of a group of amateur swimmers by means of targets or simple repeated practice in the absence of targets. In particular, we compared the effect of training with a personalised target placed just ahead of the point where the swimmer usually touches the water with his/her hands with that of a standard target appended at the backstroke indicators, i.e., a distance-marker that is present in standard swimming pools and often indicated by coaches to improve dive length. Both the personalised and the standard target and the instructions (i.e., “point at the target in the flying phase of the dive”) favours an external focus of attention (e.g., on effects and goals), which many researches (e.g., recently An, Wulf, & Kim, 2013; Lohse, Sherwood, & Healy, 2013) has shown to foster performance more than an internal one (e.g., focused on movements or body positions) in many sports (see Wulf, 2013 for a review), included swimming (Freudenheim, Wulf, Madureira, Corrêa, & Corrêa, 2010) and at any level of expertise (Wulf, & Su, 2007), hence also for amateurs.

Results confirmed that both targets (i.e., standard and personalised) were more effective than repeated practice, but also showed, as hypothesised, that the personalised target was more effective than the standard. This difference could be explained by the goal setting theory, which posits that a target, to be effective, has to mark a difficult, yet challenging (but not impossible) distance. In contrast, the standard target was extremely difficult for

amateur swimmers: it was not motivating and challenging because it was impossible to reach. However, due to the external focalization of attention, the standard target resulted more beneficial than repeated practice.

The present results showed the greater efficacy of the personalised target in comparison to the standard target, and that of the standard target in comparison to the simple repeated practice. In addition, the analyses performed on the training dives revealed that the advantage of the personalised target was large, evident since the first training dive, and constant throughout the training. These effects could be explained by affordances, i.e., opportunities for action (Gibson, 1979, see Fajen et al., 2009, for affordances in sport psychology). The personalised target in particular, could prompt a catching behaviour (some swimmer did touch the target with the fingertips in the training dives). In addition, it could implicitly promote attunement to the motor action that is necessary to lengthen the dive. Research has in fact demonstrated that affordance is crucial for successful performance in many sports and everyday movements (e.g., Day, Wagman, & Smith, 2015), and in particular when dynamic aspects are considered (Cole, Chan, Vereijken, & Adolph, 2013). Along the same line, the results stress the efficacy of ecological trainings that are tailored on the individual (e.g., Davids, Araújo, Hristovski, Passos & Chow, 2012).

The current results do not show that a target such as the standard target is an ineffective target per se. They stress, in contrast, that targets need to be made as a function of the individual swimmer's skill. Here, the standard target was too difficult for the amateur swimmers recruited for the study. However, this same standard target could be effective in improving the performance of elite or professional swimmers, i.e., of swimmers that dive much longer than the swimmers of the current study. The present results also show that the improvement made in the group using the personalised target was large, measuring an average improvement of ~30 cm, i.e., an increment of 10% of the dive length recorded before the training. In comparison, the increment recorded with the standard target was only ~10 cm (4%). We believe that this large improvement can be partly explained through the use of an effective, swimmer-specific target. However, this large improvement could also be attributed to the starting level of the chosen participants, i.e., amateur swimmers. Amateur swimmers have great margins of improvement. It is possible that elite or professional swimmers would show smaller improvements.

The results of the current experiment propose an effective method for improving dive-length. This method consists of placing a target at a personalised distance, in order to create a specific, difficult enough and challenging

goal to which each swimmer could be committed, thereby encouraging motivation. This personalised target substantially improved the dive-length of a group of amateur swimmers (i.e., swimmers with a wide range of improvements) in a single training session composed of ten dives. Therefore, the method is likely to be successful with swimmers that have wide margins of improvements such as amateur swimmers, master swimmers (the competitive swimming over 25 years of age), and young agonistic swimmers. Future studies are needed to corroborate the present results with larger samples, different types of swimmers or different sports (e.g., long-jump). Since the personalised target increased the dive-length in a single training session, it could also be used to shorten training sessions that are dedicated to improve dive-length. Furthermore, in elite professional swimmers the target could be used to selectively train those swimmers that need to focus on lengthening the dive.

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