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Original Article

Towards a Safe Aquatic Literacy: teaching the breaststroke swimming with mobile devices' support. A preliminary study

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Abstract:
Problem Statement: Technical swimming skills, the breaststroke in particular, are basic for a safe aquatic literacy and drowning prevention. Learn-to-swim programs cope to several teaching constraints, including providing adequate feedbacks to the learner to guarantee the best motor control and skills' acquisition. Recent technology makes mobile devices user-friendly and suitable in providing video feedbacks to the athletes or to the learners during coaching or teaching physical education and sports, even in particular environments, such as swimming pools. Approach: In this study, we supported a breaststroke learn-to-swim program with video feedbacks by mobile devices (MDS) and we compared the outcomes to a program in which the teacher used conventional feedbacks, comments and corrections, only provided by gesture and verbal communication (C). Sixteen young participants (20.6±0.5 years) were assigned to MDS or C. Before and after the 8-weeks learning program, the breaststroke skills of the participants were evaluated by both quantitative and qualitative analysis. Purpose: The study aimed to assess whether augmented feedbacks improved the learning of breaststroke skills more than the standard approach commonly used in swimming schools. Results: MDS and C resulted comparable, as no interaction was retrieved from the Mixed-model analysis of variance. However, the qualitative analysis revealed that MDS improved in a higher number of features among those observed. Conclusions: The results seem to indicate that learn-to-swim programs with augmented feedbacks, as by mobile devices, might be beneficial to the learners and recommended to the teachers.
Key words: Drowning prevention, teaching, feedback, motor learning, methodology

Introduction

Reports by National and International public organizations show that drowning is source of death for many people in Italy and worldwide (Funari & Giustini, 2011; WHO, 2014). Drowning risk depends on several causes, such as accidental falls in the water, lack of supervision of young children, living or working near water, travelling on water, natural disasters.

Several actions have to be addressed to preserve the personal safety and to prevent drowning, e.g. community-based policies, legislation and strategies. Among them, teaching basic swimming techniques, water safety and rescue skills are recommended (WHO, 2014). The wider concept of "water competence" (Stallman, Moran, Quan, & Langendorfer, 2017) combines all of them towards a "safe aquatic literacy". However, although this concept is actually more extensive than "to swim a stroke" alone, skills as swimming regular strokes are crucial for personal safety. In particular, among the strokes, breaststroke has been identified as the best to be mastered in beginners because of its guarantees of excellent safety in the case of accidental falls into the water, which requires to swim in clothes, or when tasks such as vertical and horizontal water treading or position changing have to be performed (Potdevin, Jomin-Moronval, Pelayo, & Dekerle, 2017).

The breaststroke's relevance for safety can be possibly explained by their symmetrical movements, as well as the possibility to raise the head out of the water to breath, float and displace quite easily. Conversely, breaststroke has been found to be the most expensive among the four conventional swimming strokes (Tiago M Barbosa et al., 2006).

That said, the more the breaststroke technique is skilled, effective and far from expensive movements, the more it properly and economically copes with unexpected events causing risks of drowning. This makes appropriate the acquisition of breaststroke skills also to purposes of convenience and not only for better performing in the swimming courses, as one may commonly thought. This study was therefore focused on learning and perfecting the breaststroke technique.

To properly improve the learners' breaststroke technique, teachers have to select and use the more appropriate strategies and methodologies to be successfully applied in motor learning, and in the learn-to-swim programs in particular. A preliminary constraint to be considered is the specific environment in which the swimming teaching and learning processes take place. This means that teachers have to pay particular attention

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while choosing their teaching approach to limit the sometimes ineffective communication strategies deriving from the ordinary situations of mess and noise of swimming pools (Bielec, 2007). Similarly, due to the altered sensory-perception conditions originating from the aquatic environment that modify the pressure, the drag and the balance (Pendergast, Moon, Krasney, Held, & Zamparo, 2015), as well as further social, emotional and cognitive features (Lémonie, Light, & Sarremejane, 2015), teaching strategies should be carefully selected. As an example, visual information as a coded gesture language was found to considerably help the instructors in providing corrections and teaching the right motor tasks, more than the verbal communication alone (Burzycka-Wilk, 2010).

With this in mind, swimming teachers have to plan the most successful methodological process which help the acquisition of the specific technical tasks to be learned, with particular regard to the specific condition of the aquatic environment. In terms of practical applications, the spectrum of the teaching styles (Mosston & Ashworth, 2002) can be applied and properly oriented to enhance the learning process (Invernizzi et al., 2019). Learner-centered pedagogy and reflection-action processes can be used in sports in which the technique is a relevant part of their outcome, such as swimming (Light, 2014). Feedbacks from the teacher or from other sources further help these processes.

Nowadays technological products, the mobile devices in particular, are within everyone's reach, and are extremely friendly and easy to use for recording short videos of the athletes performing a task, to be immediately showed and commented to them. This may help the teachers to enhance the activation of the learners' cognitive processes involved in learning and motor control. Examples of video-feedbacks supporting the learning process come from the literature, in both coaching and teaching (Guadagnoli, Holcomb, & Davis, 2002; Madou & Cottyn, 2015; Wilson, 2008). They support the neurocognitive processes involved by simply watching the execution of a task, even when it is performed by another person, that basically increase the activation of motor-evoked potentials by observing (Aglioti, Cesari, Romani, & Urgesi, 2008). Furthermore, specific applications of video-feedbacks in swimming have been already contemplated by Syahrastani (2014), showing that structured multimedia sources improve the learning of the breaststroke technique more than the standard swim teaching methods.

Therefore, the aim of this study in young beginners was to compare the effects of a short-delayed video-feedback provided by a mobile device during a breaststroke teaching program to the standard teaching approach in which the teachers provide conventional feedbacks, comments and corrections, only by means of gesture and verbal communication. Should mobile devices help the learning process of complex tasks such as swimming, new insights on learn-to-swim strategies may originate and enhance the safe aquatic literacy.

Material & methods

Participants

Sixteen sport science students volunteered to participate in the study (age 20.6±0.5 years, 8 males, 8 females). They all were non-swimmers, novice with basic breaststroke skills. Due to the study design aiming to principally assess the effects of different teaching methods on swimming skills, participants have been equally divided by gender in the experimental groups, but afterwards considered in aggregate form (males and females). Two groups of eight participants each (4 males and 4 females), composed: an experimental group, which was taught with mobile devices' support (MDS), and a control group (C), as later detailed. The study was conducted in accordance with the declaration of Helsinki and was approved by the local university ethics committee.

Procedure

Participants attended 8 weeks of learn-to-swim lessons, once a week, lasting 45 min. Being the participants basically skilled in breaststroke, the learn-to swim program was mainly aimed to improve the action of the legs and the overall breaststroke coordinative pattern. Indeed, they are the main difficulty that beginners have to overcome while learning breaststroke. In addition, they are crucial to produce an effective and economic breaststroke for the safe aquatic literacy.

At each lesson, before entering the water, the participants were asked to carefully watch a breaststroke's demonstrative video-clip, and to focus the attention on the specific topic of the lesson. The video has also been given to them so they could watch it at home during the whole experimental period. After 5 min of warm-up, the participants were taught with a reproductive teaching style throughout the first 20 min, followed by 20 min of free practice without feedbacks to consolidate the stroke.

The learn-to-swim program of C and MDS was similar. Compared to C, MDS only differed in the augmented feedbacks that teacher offered them in the first 20 min by a mobile device (Apple iPad, 2nd generation). The teacher video recorded the beginners while swimming for at least 10 s, and immediately after showed and commented the videos providing feedbacks and corrections to the learners. MDS received at least 4 video feedbacks per lesson.

Differently than MDS, C was taught in an ordinary way, i.e. receiving verbal feedbacks, explanations, suggestions and corrections, only supported by teacher's gesture and verbal communication.

To assure that all participants might be carefully assisted by the teacher, each class was composed by a maximum of 4 swimmers.

Testing and data collection

Before and after the teaching period, participants were measured and evaluated by a both quantitative and qualitative analysis. They were asked to perform two 25m breaststroke trials: i) swimming the fastest as possible, and ii) swimming the best as possible. Measures and scores were collected in a second time, from the video recordings of the whole testing procedure. During the testing procedure, participants were not aware of the assessment procedure that will be afterwards accomplished. They were only asked to swim fast or well.

The quantitative analysis intended to assess some of the most common parameters that are used in research for the evaluation of swimmers. We therefore measured: the performance on 25m (Time; s), starting with pushing off the wall; the velocity in the central 10m ($v10$; m/s); the stroke rate (SR; cycles/min) and the stroke length (SL; m/cycles).

The qualitative analysis intended to score some of the specific features of the breaststroke technique (Coordination, leg action and Total sum of them). To do that, an evaluation sheet was designed (Table 1), based on the logical construct of the stroke and originated from the biomechanics of breaststroke, as described by Maglischo (2003). Its pertinence to evaluate the breaststroke skills had been previously discussed and agreed by two experienced swimming coaches. Each feature was scored from 0 to 5 points.

A test-retest procedure was accomplished by twice scoring a sample of video recordings of the breaststroke swimming (the repeated evaluation one week after the first), and showed a good consistency.

Table 1. Features composing the evaluation sheet used for the Qualitative analysis of the breaststroke skills

Feature	Skill to evaluate	Description
Coordination	Swim cycles	Arms:legs = 1:1.
	Timing head and shoulders	Head and shoulders raise as the arms sweep out. They are out of the water as the insweep with the arms begins, the head not over-extended.
	Timing breathing and arms	Breathing happens during the arm recovery, from the insweep with the arms.
	Timing breathing and legs	The head is submerged when the arm recovery has ended, and before leg kicking.
	Timing arms and legs - gliding -	There is a short time between the end of the kick and the beginning of the arm stroke, the swimmer gliding in the streamlined position.
Leg action	Hip flexion angles	From 110 to 130 degrees.
	Overall legs kinematics	Quick recovery without abruption, the legs relaxed. Kicking with progressive increase of the velocity.
	Knee and feet distance	Knee and feet quite close together during recovery, the feet more open at the beginning of the kick.
	Feet/Ankles position	Feet dorsiflexed while kicking, extended while gliding.
	Trajectories	Legs and feet move in a symmetric and simultaneous way.

Statistical analysis

The IBM SPSS Statistics software (v 25.0. IBM Corp, Armonk, NY, USA) was used for statistical analysis.

The homogeneity of C and MDS groups before starting the experimental period was verified from an Independent-Samples t-test. The normal distribution of data was checked by the Shapiro-Wilk's test and a parametric statistical analysis was then applied. The effects of the two teaching methods were assessed by a Mixed-model analysis of variance, searching for interactions.

Pre-Post differences for each variable were assessed by Paired t-test. Paired t-test was also applied to compare the Total scores assigned in the Post conditions, corresponding to swimming the 25m breaststroke at maximum velocity and to "swimming to the best", in both C and MSD. The level of significance was set at $\alpha<0.05$.

Results

As shown in Table 2, the Mixed-model analysis of variance did not find interactions between the teaching methods, highlighting that C and MDS have been in general affected by the two approaches in a comparable manner.

Table 2. Results of the Mixed-model analysis of variance comparing C and MDS

Measure		Mean Square	F	Sig.
Quantitative analysis	Performance (Time)	2.290	.760	.402
(only at maximum velocity)	*v*10	.021	1.530	.242
	SR	1.762	.043	.839
	SL	.038	1.135	.310
Qualitative analysis	Coordination	20.331	2.862	.119
- at maximum velocity –	Leg action	2.382	.314	.587
	Total	8.795	.423	.529
Qualitative analysis	Coordination	15.956	1.820	.204
- swimming to the best -	Leg action	2.110	.419	.531
	Total	29.670	3.679	.081

*v*10: velocity in the central 10m; SR: stroke rate; SL: stroke length.

Figures 1 and 2 provide an overview of changes occurred between Pre and Post, for each specific parameter.

Figure 1 shows the results of the quantitative analysis. C and MDS lowered *v*10 by 20.0% (0.80±0.1 vs. 0.64±0.1 m/s; *P*<0.05) and by 29.8% (0.94±0.3 vs. 0.66±0.1 m/s; *P*<0.05), respectively. They also reduced SR by 39.3% (50.44±7.5 vs. 30.62±4.8 cycles/min; *P*<0.05) and by 37.1% (50.62±5.6 vs. 31.84±4.5 cycles/min; *P*<0.01), respectively. C increased SL by 29.6% (0.98±0.2 vs. 1.27±0.2 m/cycles; *P*<0.05).

In Figure 2, the results of the qualitative analysis are reported. Total scores increased in C by 17.4% (32.7±4.0 vs. 38.4±3.7 AU; Pre vs. Post; *P*<0.05) and in MDS by 37.2% (27.7±8.3 vs. 37.7±10.4 AU; Pre vs. Post; *P*<0.01). MDS also enhanced coordination at the maximum velocity by 44.6% (10.8±4.1 vs. 15.6±4.4 AU; Pre vs. Post; *P*<0.05), whereas when "swimming to the best" they improved both coordination and leg action, which scores raised by 50.0% (12.0±4.2 vs. 18.0±5.9 AU; Pre vs. Post; *P*<0.05) and 25.5% (15.6±4.9 vs. 19.7±5.1 AU; Pre vs. Post; *P*<0.05), respectively.

Figure 2 also shows that, comparing the Total scores in the Post, C differed when the task was performed at maximum velocity with respect to when it was performed by "swimming to the best" (33.5±6.2 vs. 38.4±3.7 AU; *P*<0.05), whereas MSD scores were comparable and no differences were found between them.

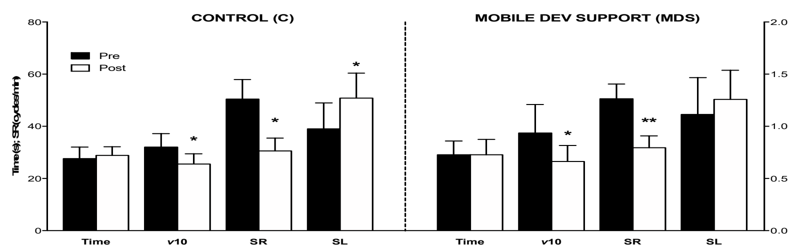

Fig. 1. Quantitative parameters measured before and after 8 weeks of learning. *P<0.05 vs. Pre. **P<0.01 vs. Pre.

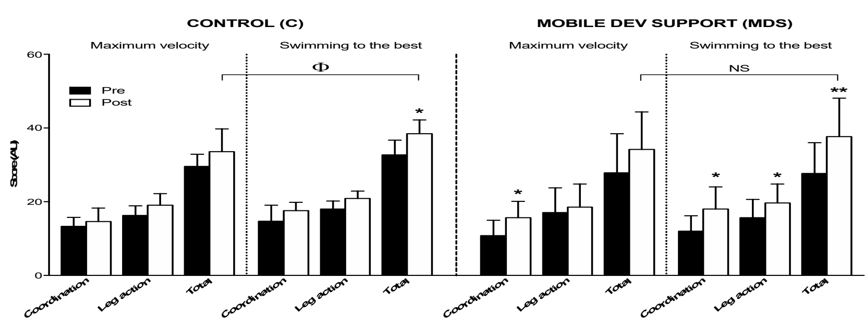

Fig. 2. Qqualitative evaluation of the breaststroke skills scored by video recording of the 25m task performed "at the maximum velocity" and "swimming to the best", before and after the 8 weeks of teaching period. *P<0.05 vs. Pre; **P<0.01 vs. Pre; Φ P<0.05 vs. maximum velocity.

Discussion

This study aimed to assess whether augmented feedbacks by mobile devices improve the learning of some breaststroke swim skills, beneficial for safe aquatic literacy, more than teaching with a standard approach in which feedbacks, comments and corrections are provided only by means of gesture and verbal communication. Both approaches resulted comparable. Nevertheless, participants receiving additional feedbacks from mobile devices improved in a higher number of the observed features.

From the Mixed-model analysis of variance to compare C and MDS (Table 2) no interactions were found, hence they both improved. This does not agree with a previous study of Syahrastani (2014), that used multimedia to improve the breaststroke technique and that turned to be more successful than a teaching approach supported by only images. Actually, in our study, both C and MDS were asked to watch a videoclip showing a correct breaststroke before each class, and to focus on the topic of the lesson. They all might have benefited from the multimedia support.

The mobile devices such as tablets or phones offer simple and user-friendly tools akin to the more complex and expensive settings dedicated to research that support coaches in the athletes' training, and they can also be easily used in teaching, even at a swimming pool. We would have expected a more powerful effect coming from the additional feedbacks that teacher provided to the learners by the iPad, and we would have expected that MDS enhance the breaststroke skills more than the C ones. Indeed, video technology has been already recognized as convenient to coaches and practitioners to analyze, assess and monitoring the technical skills and feedbacks of the athletes (Wilson, 2008), and it is nowadays widely used in training.

Conversely, statistics suggests that C and MDS enhanced their skills regardless of the learning approach, i.e. regardless of supplement of feedbacks by mobile devices. Indeed, in physical education classes, the simply introduction of iPads for recording and displaying to the learners their own just before executed skills was found to be insufficient to improve the learning process (Madou & Cottyn, 2015). The authors adduced as explanation that they missed attentional cues, which were not provided. Differently, in our study the teacher supplemented the vision of the just before executed task with several cues, offering to the learners a broad analysis and a lot of suggestion and instructions to improve the skill. Possibly, learners may not have been skilled enough to cope to so many information and details as provided by the teacher, being the participants novices and being swimming a particularly complex task. As a matter of fact, expertise is relevant to better interpret information gathered from a videoclip. Aglioti et al. (2008) found that skilled athletes predict the success of a free shot simply by watching it in a video, more accurately than novices or individuals with comparable visual experience but not comparable skill level do, such as coaches or journalists. Execution and observation of a given action activate neurons of the both premotor and parietal cortex.

The quantitative analysis (Fig. 1) confirmed that all participants improved in breaststroke skills. Even if the performance at a maximum velocity did not change in the Post (possibly because of the short duration of the treatment), SR and SL respectively lowered and increased, indicating that the technique has qualitatively improved, becoming more efficient.

However, from an overview of changes from Pre to Post of the qualitative analysis, we can add further considerations leading us to sustain that MDS resulted to some extent better than C, and therefore that the use of mobile devices induced a more positive effect on participants than the standard teaching approach. Indeed, the Total scores of the qualitative analysis when "swimming to the best" had a value of interaction close to the significance level (Table 2, $p=.801$). The Total score, being the sum of the coordination and leg action scores, is the most representative parameter to evaluate the overall breaststroke skills of the participants. Therefore, considering that in this preliminary study the number of participants of was quite little ($n=16$), that the volume of the treatment was not very extensive (20min per week, for 8 weeks), and that the standard deviation of MDS was rather large (Fig. 2), we can look beyond numbers and further enphasize the trend of the data, that cannot be disregarded as it possibly denotes a positive effect of the augmented feedback. After all, the literature argues that visual information in teaching is more efficient than verbal information alone (Burzycka-Wilk, 2010). The higher number of features in which MDS qualitatively improved compared to C seems to corroborate that.

Finally, there is another evidence of the relevance of the augmented feedbacks. In Post, all participants improved the Total scores when "swimming to the best" (Fig. 2). However, if we compare the within group Total scores of the Post, C better performed when "swimming to the best" than when swimming at the maximum velocity, while MDS obtained comparable scores. Therefore, differently than C, MDS had a comparable high-qualitative breaststroke in both swimming conditions (to the best and at maximum velocity). Considering that the instructions provided to the participants for the testing procedure were only "swim fastest" and "swim to your best" and that they were not aware of the scoring procedure that will be afterwards accomplished from the video recordings of the trials, we can assume that MDS consolidated their technique more and better than C, and that they preserved a high quality of breaststroke even when asked to swim as fast as possible, and not only when they had to focus on the stroke quality.

The little number of participants and the low volume of the treatment were definitely the main limitations of this preliminary study.

Conclusions

This study applied recent technological devices such as tablets or mobile phones to the teaching process of the breaststroke technique towards a safe aquatic literacy. Based on the results, the devices can be easily used by the teachers to increase the feedbacks, supporting the novice swimmers during the acquisition of the breaststroke skills. Specifically, the use of the augmented video feedbacks was compared to another teaching approach providing feedbacks, comments and corrections only by means of gesture or verbal communication, as usually teachers do. Results show that the two teaching strategies are comparable, but additional analysis of the qualitative outputs of the breaststroke technique seems to support that providing video feedbacks and cues by mobile devices is an easy for teachers, and beneficial for learners, procedure. A more extensive and solid application with a larger number of participants and with higher volume of treatment should follows to strengthen this assumption.

Conflicts of interest

None.

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