DIFFERENCES BETWEEN EXPERTS AND NOVICES IN FIN SWIMMING: A COGNITIVE SYSTEM ANALYSIS

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Abstract
The following presentation will focus on a cognitive systemic analysis of the behavior of expert and novice fin swimmers. The central assumption of this study is that the previous knowledge of the athletes in the swimming style of "butterfly" makes the empirical performance of the new dolphin style difficult, because of the similarity of two movements. The Fin swimming style starts with the *up and down* propulsion instead of the *down-up* movement of butterfly (Pictures 1-2). The action in the new style is in waist and the reaction part is in the legs. The reorganization of the prior model of butterfly is necessary for that empirical performance. Without this mental change the nervous system of the athlete is unable to assimilate and perform the proper style. A cognitive psychological account of the behavior of the swimmers will be described to support the above-mentioned view. The results of an empirical study will be presented to support the following arguments:
A) Prior Knowledge of butterfly swimming inhibits the acquisition of the correct movement in "fin" swimming.
B) Novices do not appear to be aware of the conflict between old and new movements.
C) Experts are more aware of the conflict but the two styles in practical performance still show interference effects.

Keywords
Cognitive systemic analysis, Pre-existing knowledge in Butterfly, Synthetic mental model of fin swimming style

1. INTRODUCTION

So far studies in the motor learning and motor behavior have paid a little attention to the prior knowledge and how this interacts with new knowledge. All the current methods of technique correction used by coaches rely on *practice and repetition* of the right way in athletic performance [Tutko & Richards, (1971)]. The emphasis to these methods derives from the assumption that the neurobiological factors and the functions of the nervous system underlie motor learning and motor behavior.

However, although practice is valuable and necessary for learning a new skill, experience confirms that practice, when done in the same way as with the learning of a new skill, is much less useful when trying to change an existing, well practiced, and automated skill [Baxter P., et all, (2002)]. Athletes often seems to improve practice during their daily training but they appear to forget what they have learned when left to their own devices, as in the heat of competition, in hard training and in the beginning of the next years' season. Further more, a *practice-based method* cannot provide a stable correction of the technique errors, as *proactive inhibition* [Baxter P., et all, (2002)] does not discriminate between the right and the wrong in a given context. Metacognitive methods are necessary if an athlete wants to overcome proactive inhibition, to deautomatize a learned error [Shanon (1990, 1998)] and to perform the proper style.

New Science of learning as an applied multidisciplinary perspective of cognitive science examines the prior knowledge in different fields (mathematics, history, physics, astronomy, sports, chess, music). According to the cognitive approach to learning process, the concept of pre-existing knowledge is vital as this process is guided by previous concepts, believes, thoughts, perceptions, skills and practices. Further more the new concepts, are going to be analyzed, organized and memorized in the base of pre-existing knowledge.

The educational environment according to the new theory of learning plays also an important role in the motor learning procedure as it determines the way that the learner is going to interact with the new information. Under the notion of active and dynamic subject the educational environment has to provide learning with understanding, to be learner-centered and knowledge centered. Such an environment enchases learning with understanding as the previous knowledge, cultural practice and beliefs are connected with current learning tasks.

The dynamic of brain adaptation through the learning experience is also a basic parameter in the context of new learning theory. A lot of studies have shown that learning changes the physical structure of the brain and with it, the functional organization of the brain. Research evidence suggests that learning experiences associated with activity in the nervous system causes nerve cells to create new synapses. In essence, the quality of information to which one is exposed and the amount of information one acquires is reflected in the structure of the brain [Bransford et all (1999)].

Sport behavior as a multilevel behavior needs a cognitive, neurobiological, and educational system approach to be analyzed. Without this multidisciplinary systemic analysis the description of the motor behavior will end to a reductionism, which cannot be supported by the empirical evidence.

2. The Present Study

The aim of this study is to examine the role of prior knowledge in butterfly style in the acquisition of the new fin swimming style. The reason for this study was the technique problems and performance difficulties that the athletes of fin swimming experience during their daily training.

The present study examines the following assumptions:

1. The first assumption is that the prior butterfly style stands in the way of developing expert performance in fin swimming.
2. The second assumption is that the athletes construct a mental model to compromise the distinction between butterfly and fin swimming style. This dynamic structure is formed of and constrained by underlying structure of butterfly knowledge.

According to the above assumptions is expected that athletes will show inconsistency with coaches' fin swimming model not only at the practical but also at the theoretical level. For that reason a questionnaire with 30 questions was used to measure this assumption. The expected inconsistency at the athletes' answers would imply the use of mental model that is different from their coaches' fin swimming model. Because of the existence of this butterfly mental model it seems that the existence of the technique problems will be permanent and resistant to change.

3. Theoretical Basis

The theoretical basis for this study is the mental models theory [Johnson-Laird, 1981, 1983]. The categorization of athletes is based on studies in novices and experts in physics, history,

mathematics, music and sports (M. Chi 1978, 1981, A K. Ericson 1991). According to *mental models theory* [Vosniadou and Brewer, 1992] when the inputs are incompatible with the pre-existing knowledge then learner construct a dynamic structure-a mental model to compromise the distinction and to analyze the external world. This dynamic structure is formed of and constrained by underlying conceptual structures.

4. Methodology

(α) **Subjects**

In the present study 21 athletes of Fin swimming took part. The age range for the experts was between 15 and 27 and for the novices 10-15. Most of the athletes had prior experience in Swimming, particular butterfly. Two athletes had prior experience in synchronized swimming and one athlete hadn't a prior experience in any sport. From the above athletes, 10 were girls and 11 were boys. All the athletes were Greek citizens except one who was from Ukraine.

The categorization of the athletes in experts and novices is based on the following objective criteria:

- Years of participation in the sport of fin swimming. The experts had 6 to 10 years of participation in the sport. Novices (N=9) had 1 to 3 years of participation in Fin Swimming.
- Participation in the National Team of Fin Swimming. All the experts (N=12) where athletes in the National Team.

(b) **Procedure**

The hypothesis was examined in three ways:

1. The athletes had to complete a questionnaire. The questionnaire was divided in four parts. The first part (**Q1, Q8**) had general questions for the sport of Fin swimming and for the swimming style of the athlete.

The second part (**Q12**) was examine the awareness of the athletes for distinctions in the description of the style.

At the third part (**Q19**) we were looking for the existence of mental model with casual form of knowledge.

The last part of the questionnaire (**Q24**, **Q29**, **Q30**) was focus on metacognition (*Developing* a plan of action, m*aintaining/monitoring* the plan and e*valuating* the plan) and the awareness of the athletes on having "blanks" in their understanding.

2.After the questionnaire some of the athletes gave an interview individually for 20-30 minutes that was recorded by a tape recorder. The methodology of the interview was (a) You could think aloud. (b) Describe the style by using your body and (c) If you think it's necessary you can draw the style. The basic form of questions was used for all the athletes. Specialized questions were used according to the answers that athletes had given at the questionnaires.

3.The last step was the practical exercises that the athletes of National Team had to perform, (25m immersion, 50m surface, 100m hands down and legs dolphin style, 1 starting, 1 turn). The basic goal of this step was to check if there was a similarity or not with the answers at the previous levels. The exercises had to be carried out during the training program of the athletes. The coaches of the National Team had to observe and mark their performance.

5. Scoring

The data where scored first at the cognitive level (description and understanding of new style) and second at the metacognitive level (kinesthetic awareness, monitoring and controlling the performance).

Table 1. Questions about the Fin Swimming Style and athletes' answers *(N=21)*.

Questions	**Experts (12)**	**Novices (9)**	**Expected Answer**
Describe the way you swim today. **(E1)**	I bend my knees.	I bend my hands and my waist.	**I bend my knees and my back.**
What do you want to change to your style? (**E8)**	To stop bend my knees, to correct the position of my hands and my head. To stop moving my back. My waist deeper.	My hands and the movement of my waist.	To stop bend my knees, to correct the position of my hands and my head. To stop moving my back. My waist deeper.
When you swim you are thinking the style: **(E12)**	**According to my model.**	**According to my coach's model.**	**Ex:** *According to my model.*
The style in F.S has to phases {up and down propulsion). **(E19)**	At upper phase legs come into the water and waist arises.	After the turn, the athlete takes the position for immersion. The start of the propulsion is downward.	**Ex:** Upper phase: *Down waist - feet up.* Downward phase: Waist up - feet down. After the turn first movement upper. **Nov:** The opposite answer.
The next season: **(E24)**	I swim according to my style and not my coach's.	I need time to find the style.	As they were phrased.
(Y*our weight has been moved from your back to your legs. Is there going to be any change to your swimming style? (***E29)**	Yes.	I don't know.	Yes.
How do you deal with a situation as is described in the previous question. **(E30)**	I'm going to correct the upper part of my body: I'm stretching my hand forward and I bend a little more my head.	I don't know.	As they were phrased.
Conclusion	Kinesthetic awareness, monitoring the performance. Aware of the technical problems.	Not appear to be aware of the conflict between old and new movement.	

Table 2. Results of Experts' Practical Exercises *(N=12).*

Exercises	**Experts' Style**	**Conclusion**
25m immersion,	Butterfly (legs)	The athletes swim butterfly.
50m surface	Butterfly (legs)	
100m hands down and legs dolphin style	Synthetic (waist –legs)	The two styles in practical performance show interference effects.
1 starting	Butterfly (legs)	The athletes start the propulsion downwards, they swim butterfly.
1 turn	Synthetic (waist - legs)	The two styles in practical performance show interference effects.

6. Results

The results show that pre-existing knowledge of butterfly prevents the learning of new style in Technical swimming. According to the answers at (**Q1, Q8**) athletes at both levels are able to numerate and describe the technique problems they are facing up. These technique problems (bend of knees, movement of back and waist) are directly linked with the butterfly style. (You bend your knees because you start the style with down propulsion so your back can't be stable. The same happens with the movement of the waist: If the propulsion is downward athlete cannot bend his waist.

A question 12 show that experts because of the technique difficulties have developed a different model from their coaches' as the previous knowledge cannot be isolated so this knowledge is activated in their daily practice. At the early stage of the novice the contradiction doesn't seem to be obvious or conscious as novices have little practice experience and for that reason they focus on their coaches' model for their performance.

At **question 19** the athletes had to describe the propulsion and to answer how do they start the propulsion. The half of the experts gave wrong answer and all the novices gave only wrong answers.

At **question 29** the experts gave the right answer but only one athlete could link this problem with the butterfly style. This athlete hadn't any butterfly background and his coach had given him a wrong/right description of the style.

At the last **question (30)** only the experts gave a full description. The novices couldn't give a solution to the problem.

At the practical exercises experts' technique has elements from butterfly and fin swimming style. When they have to swim fast then their style is the butterfly and when they have to start the propulsion after the start or the turn they swim also butterfly. Only two athletes had different performance. The one had the proper style and the other had a synthetic style. These athletes had no butterfly background and wrong/right description of the style.

7. Discussion and Conclusion

Athletes of Fin Swimming confuse the butterfly with dolphin style because of the similarity of the two movements.

The way that this particular knowledge interacts not only with new information but also with practice gave the following form to the categorization of athletes:

1. Novices and Inert prior knowledge: *Missing of understanding.*
2. Experts and Active Prior Knowledge- Active New Knowledge: *Cognitive conflict.*

This confusion is unconscious in *novices* and cannot be faced up because of the isolated patterns that subscribe their understanding. Novices are able to describe the right style but this ability arises from the memorized words of their coach. For that reason (**Q24**) they need time to find the style at the next season. They aren't able to describe what is going to happen if the *weight is going to be moved from the back to the legs* and they cannot give a solution to the problem. So they do not monitoring their style and they don't seem to be aware of the conflict between the two styles.

Experts, on the other hand are unable to perform the fin swimming style without the use of metacognitive representation: *The kinesthetic aspect of athletic experience.* Experts practice the style mentally so in that level we have trials where old and new knowledge interact. Experts describe the proper style according to their own model. That model contains prior butterfly knowledge and new style so we have interaction and activation of prior and new knowledge both at theoretical and practical level. Procedural knowledge in that level is not enough for proper performance. Expert needs the kinesthetic awareness for the transformation of knowledge. Kinesthetic and emotional description of the style was given only at experts level (*I want to feel the movement, to feel the monofin).*

The study of Fin swimming shows that prior cognitive models subscribe the procedure of motor learning. A limitation at performing new dolphin style arises from the pre-existing

experience in butterfly. The evidence that the athletes swim in two ways while at theoretical level are able to give a full description of the proper style has the following consequence:

- The athletes use the proper model to describe the dolphin style and the butterfly model to perform it.
- The nervous system is unable to provide the performance of the proper style without reorganization of prior knowledge and understanding in learning new dolphin style.
- The interaction of cognitive, neurobiological, and educational systems is vital for the description of motor learning and motor behavior.
- Philosophy of training must change. An athlete has prior knowledge and prior experience so he is unable to "forget" prior experience (in cognitive or in nervous level) in order to learn a new sport or to have different training with a different coach.
- Further more, athletes need to discuss their opinions with their coach and must be aware of prior knowledge and how to use this knowledge. Coach and athlete must share a common semantic field, which provides a dynamic and active learning of new motor skills.

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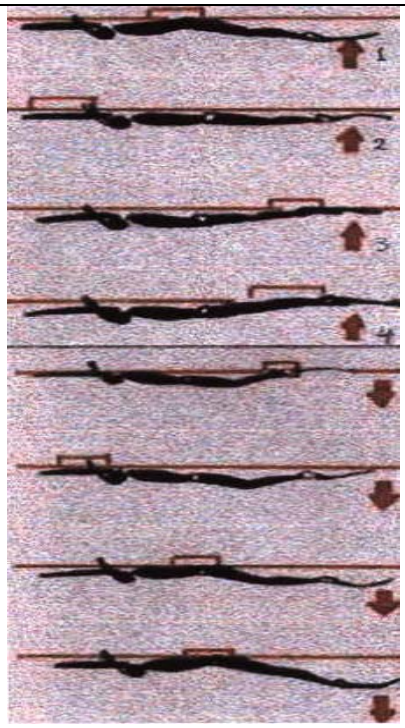
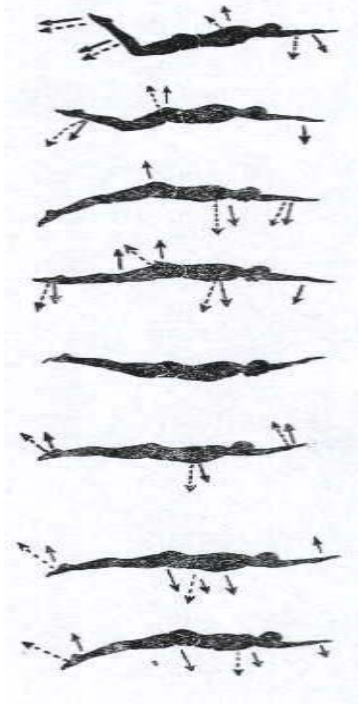


Picture 1
The propulsion in fin swimming starts with upbeat kick. During the upbeat kick (figures 1-4) waist comes into the water (action) and monofin arises (reaction).



Picture 2

Propulsion in butterfly is *down up.* Legs come into the water (action) and waist arises (reaction) (1-4).