KINEMATIC VARIATIONS BETWEEN SWIMMING STROKES WITH EYESIGHT DEPRIVATION

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The purpose of this study was to investigate whether or not swimming eyesight deprivation (SED) affects swimming stroke kinematics, when compared to normal eyesight. Sixteen participants, 12 male and 4 female, swam under three conditions: normal swimming, SED seeing the target, and SED without seeing the target. Data were captured using two Sony digital video cameras, placed perpendicular to the sagittal plane of swimming strokes, and behind the starting point of the swimmers. Stroke length (SL), stroke rate (SR), stroke index (SI), mean time (MT), and mean velocity (MV) were measured. Although swimmers deviated from a straight line, no significance kinematic differences were found between the three swimming conditions.

KEY WORDS: visual, swimming, kinematic.

INTRODUCTION: Controlling extraneous displacements is important in swimming. Deprivation of vision may be used as an indicator of stroke execution. Sensory-perception, coordination and short memory programs can all be related to the ability to swim in a straight line. Kinematic parameters are viewed as key indicators to biomechanically correct technique. A previous study demonstrated how well swimmers performed in managing the optimal relationships between stroke rate (SR), stroke length (SL), and stroke index (SI) for increasing mean velocity at a given distance (Kilani & Statieh, 2006). Swimmers also use sensory feedback and visual perception to align themselves for straight line (AbuAta, Abdelhaq, & Kilani, 2006).
Kinematic can explain the ability of a swimmer to maintain and control coordination of the skill. Kinematic can be determined, in a swimming pool setting, using a basic video system along with other ancillary equipment. This may aid swimming coaches in providing feedback on swimmers' technique. Parameters such as stroke length (SL), stroke rate (SR), stroke index (SI), mean time (MT), mean velocity (MV), and swimming in eyesight deprivation (SED) may help explain the optimum technique of performance. It has been suggested that the most skillful motions are programmed. and can be executed perfectly without the aid of vision relying instead on the short-term memory. Short-term memory can be retrieved prior to the onset of the motion and used as a feed forward mechanism providing imagery of the track and an aiming target (Schmidt,1999). The purpose of this study was to measure selected kinematic parameters in swimming three types of strokes - crawl, breast and back strokes - under three conditions (normal, SED seeing the target, and SED not seeing the target), and to investigate the percentage of deviation from the straight line track under the three conditions.

METHODS: Sixteen Jordanian young swimmers 12 male and 4 female volunteered for this study. Each participated in the following three conditions: normal swimming, SED seeing the target, and SED without seeing the target (Table1). Data were captured using 2 Sony digital video cameras. One was placed perpendicular to the sagittal plane of the swimmers, and the other was placed behind the swimmers' starting point. Competition conditions were adopted in order to obtain the best indicators of race performance (Sanders 2001; Sanchez & Arellano, 2002). The most important components were the start time, the turn time and the clean swimming area during which the cinematic data were captured. The order of the conditions was randomized after the base normal maximum efforts were captured. The first condition: SED while seeing the target was a condition where the subject focused on the target at the end of the 50m swimming pool prior to visual deprivation so the feedback mechanism activated the information processing as feed forward to imagine the track.

Table 1: Description of the participants.

Gender	Participants (n)	Mean Age (yrs)	Mean Training experience (yrs)	Mean Height (cm)	Mean Mass (kg)
Male	12	13.4	3.9	159.4	51.6
Female	4	14.3	5.0	162.5	58.0

The second condition: SED not seeing the target where the subject was blinded an then taken to the starting point. Subjects wore black goggles for this purpose. Ropes were installed 1 m prior to the end of the race for safety reasons (Figure 1).
Data were analyzed during this clean swimming area including the SL, SR, MV, SI, MT for each stroke and each condition. The temporal measurements were taken from the video timing device. SL was defined as the distance a swimmer's head moves during a complete arm stroke from right hand entry to the next right hand entry.

Figure 1: Illustration of the experimental setup.

This formula was used: (V/SR) to obtain stroke length. SR is the number of cycles that occur over the swimming distance. The V denotes how far the swimmer's head travels in one second, based on an average value for the entire free swimming phase where the SR and SL are determined. SI is obtained by multiplying the swimmer's V by the swimmer's SL. APAS was used for video analysis and WIZARD software was used for determining the deviation from the straight line. Descriptive statistics, Percentages and two ways ANCOVA were used for this study.

RESULTS: Table 2- 4, present the data for the three strokes under the three conditions. Left and right deviations from the baseline are shown in Table 5 as a percent deviation over the 27.5 m clean swimming area. An illustration of the three conditions vs kinematic parameters is also depicted in Figure 2.

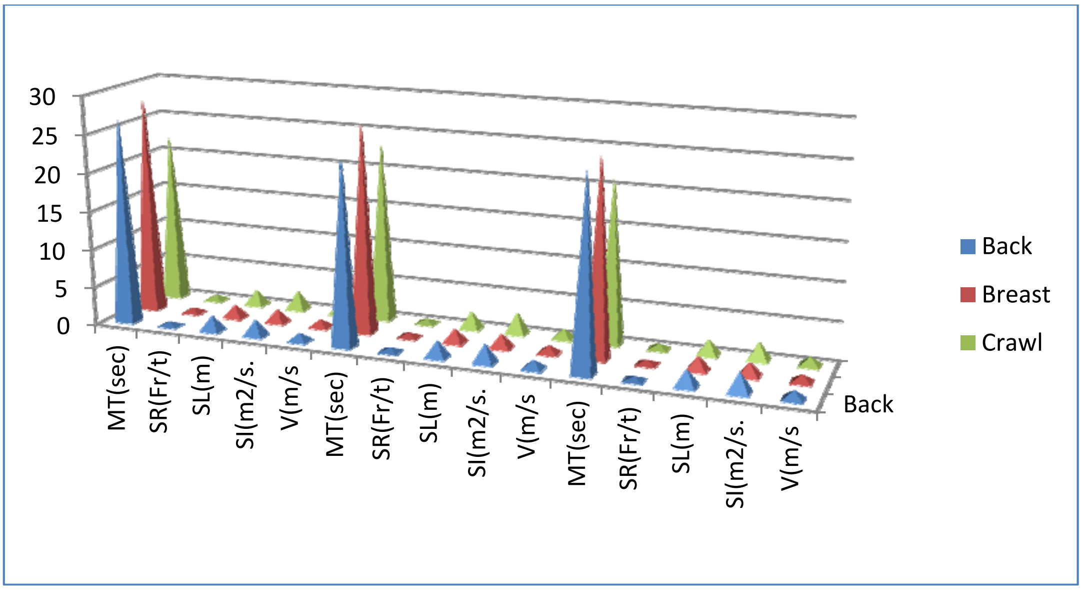

Figure 2: Comparison of the three conditions vs kinematic parameters.

Table 2: Mean and standard deviations of the parameters measured in Crawl , Back and Breast Strokes in normal vision conditions (N=16)

parameters	Crawl Stroke		Breast Stroke		Back Stroke	
	Mean	SD	Mean	SD	Mean	SD
MT(s)						
SR(Fr/t)						
SL(m)						
SI(m2/s)						
V(m/s)						

Table 3: Mean and standard deviations of the parameters measured in Crawl, Back and Breast Strokes in deprived vision condition with pre-visualization of the target (N=16)

Parameter	Crawl Stroke		Breast Stroke		Back Stroke	
	Mean	SD	Mean	SD	Mean	SD
MT(s)						
SR(Fr/t)						
SL(m)						
SI(m2/s)						
V(m/s)						

Table 4: Mean and standard deviations of the parameters measured in Crawl, back and Breast Strokes in deprived vision condition without pre-visualization of the target (N=16)

Parameter	Crawl Stroke		Breast Stroke		Back Stroke	
	Mean	SD	Mean	SD	Mean	SD
MT(s)						
SR(Fr/t)						
SL(m)						
SI(m2/s)						
V(m/s)						

Table 6 is an example of the simplified ANCOVA result which shows no significant differences in SI with respect to condition. However, the Least Squares Deviation (LSD) implementation revealed differences in the type of strokes and conditions.

Table 5: Values representing the numbers and the percentages of left and right deviation Deprived with pre-visualizing the target and Deprived without pre-visualization of the target

Stroke	total	Deprived with pre-visualization of the target				Deprived without pre-visualization of the target			
		Right deviation		Left deviation		Right deviation		Left deviation	
		%	number	%	number	%	number	%	number
Crawl	16	62.5	10	18.75	3	56.25	9	37.75	6
Breast	16	50	8	18.75	3	43.75	7	31.25	5
Back	16	68.75	11	25	4	43.75	7	31.25	5

DISCUSSION: The descriptive tables 2-4 show the means and the standard deviation of all subjects in the three conditions: normal swimming, SED seeing the target, and SED without seeing the target. The kinematic parameters are also listed against the conditions. These illustrate a numerical value to show where the greatest change in the parameters occurred. As it is shown in Figure 2, the kinematic values presented normal swimming, and the 2 deprived vision conditions. The mean time is increased for the three types of strokes. Right deviation increased drastically more than left deviation with all conditions and for all strokes. However, breast stroke right deviation was lower than in the other 2 strokes. This due to the fact that bilateral pull is more coordinated and controlled without vision. Nonetheless, all strokes need attention when vision deprived. There were no significant differences when applying the ANCOVA and LSD statistics to see the interaction between strokes type and conditions against kinematic parameters. This may due to small number of the samples.(Table 6)

Table 6: ANCOVA and least square difference LSD for SI and the interaction of condition with type of swimming. Level of significance: condition 0.458, Stroke Type(0.000), condition x Stroke Type (0.628).

	Crawl		Breast		Back		Total	
Condition state	M	SD	M	SD	M	SD	M	SD
Normal vision	2.42	0.44	1.66	0.48	2.09	2.09	2.06	0.54
Deprived vision condition with pre-visual the target	2.72	0.93	1.78	0.79	2.43	2.43	2.31	1.03
Deprived vision condition without pre-visual the target	2.26	0.83	1.70	0.87	2.62	2.62	2.20	1.39
Total	2.47	0.77	1.72	0.72	2.38	2.38	2.19	1.04

CONCLUSION: In order to improve skills and coordination, blocking of vision could be helpful to rehearse kinematic patterns of good technique without the aid of visual feedback during training sessions. Unexpectedly, breast strokes need attention as well as other strokes when vision is deprived.

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