

The Effect of Rehearsal Learning and Warm-up on the Speed of Different Swimming Strokes

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Abstract

The study investigated on the effects of rehearsal learning and warm-up exercise on the time of performing different swimming strokes. The study was conducted among 202 college freshmen students taking up a course on physical education concentrated in swimming. The design employed is a mixed factorial (2 X 2) where time of swimming is measured before and after implementing the rehearsal. The respondents underwent warm-up exercise and half of them did not receive the warm-up. Results indicate that generally, the students became faster on their speed of swimming after the rehearsal, $F(8, 191)=11.89, p<.05$ and significant differences were found between the groups that received warm-up and the no warm-up exercise on the swimming speed, $F(8, 191)=2.48, p<.05$. Warm-up exercises have significant effects specifically on one arm with breathing, back kick and arms on waist. Rehearsal learning had medium to large effect size while warm-up exercise had small effect size on swimming speed.

Keywords: *Rehearsal learning, warm-up exercise, swimming strokes*

Swimming is a form of aerobic exercise that enhances the body's fitness. Being a physical activity, different schools have started to incorporate swimming as one of the courses in physical education. One of the primary objectives in a swimming course is to enhance the swimming skills of students. There are varied measures of students' swimming skills but one considerable measure is the speed one is able to achieve during the training throughout the course. Speed is a critical component since one's body weight is about tenth of one's normal weight where one exerts pressure to complete motion in the water. The ability to surpass a small amount of time in the water would mean an enhanced exertion of movement in the water.

One of the integral factors that enhance the performance of swimming is through rehearsal. Rehearsal is the repeated recitation of an item (Sternberg, 2003). The effects of rehearsals are termed as practice effects. Through practice, one is able to become better in swimming. As evidence to rehearsal, Ebbinghaus (cited in Schacter, 1992) was able to observe that sessions repeated overtime can affect the consolidation of information in the long term-memory. However, this notion was then limited to information processing in human cognition where information is transferred in the long term memory. The information referred in the observation of Ebbinghaus is limited only to declarative memory that refers to information that are verbally explicated (Galloti, 2004). However, through rehearsal, certain

nondeclarative (not verbally explicated) tasks such as swimming is enhanced. Bandura (1977) explained the effects of practice on nondeclarative memory. It was noted in the social learning theory that motor capabilities emulates modeled actions and individuals will have the desire to want to produce the modeled behaviors. If the component of learning in his model are present, the targeted behavior will occur successfully. Through rehearsal the effect on swimming skills becomes more extended in the process where the memories are consolidated in the long-term stores (Glenberg, 1979). Costill, Maglischo, and Richardson (1992) explained that previous studies suggest that swimming better is not only dependent on one's physiological condition but more on one's swimming skills. Enhanced swimming skills are acquired through series of practice conditioning the body to move in a faster motion in the water. It is hypothesized in this study that rehearsal learning enables the occurrence of change of time in performing different swimming strokes.

Habitually, before engaging in a strenuous activity like swimming, warm-ups are conducted. Engaging in warm-up exercises prevents injuries such as knee and ankle sprains. Olsen, Myklebust, Engerbretsen, Holm, and Bahr (2005) reported that there are scientific studies that tested the effectiveness of warm-up exercises. However, these studies were deemed to have inconclusive findings. It is hypothesized in the study that the combined effects of rehearsal with the presence of warm-up exercises enhance the speed in performing different swimming skills.

Effects of Rehearsal on Swimming Skills

When adequate practice and appropriate feedback follow demonstrations, increased skill performance and learning occurs (Weiss, McCullagh, Smith, & Berlant, 2000). Behrman (2001) explained that swimming ability is related to the activity level that a person engages in. The activity level involves series of practice leading to the task needed to perform swimming. Rehearsal brings about the decrease in the response to an iteratively presented stimulus and is often thought of as the simplest form of learning (Harris, 1943; Humphrey, 1933; Kandel, 1976). The memory trace for rehearsal when it becomes a habit is within a distributed set of neuronal modifications in the brain (Hawkins, Castellucci, & Kandel, 1981; Krasne, 1993; Roberts et al., 1988).

There is considerable evidence on the effect of rehearsal on swimming. One is the study by Brown, Frost and Getting (1996) on the habituation and iterative enhancement of multiple components of the tritonia swim response. Their study clearly showed the effect of

repetitive stimulus on swimming response. They discovered that the time in swimming response depends on the intensity of the stimulus provided. Additionally, they found out that several types of acquisition curves occurred in a single experiment depending on the response component measured. Although their experiment used *tritonia diomedea* which is a kind of slug, it is evident that even in other organisms, the effects of rehearsal can be generalized.

Effects of Warm-up on Swimming Skills

The element of warm-up before swimming is designed to prepare the muscles or the beginning of the major parts of a work-out (Whitten, 1994). Warm-up exercises for swimming include tasks such as stretching, kick-pull-drill, swimming an easy 100 m, practice strokes, timed swim and sprints. They are done in order to increase the body's temperature, heart rate, blood pressure and energy producing enzyme activity making the body ready for strenuous work. These warm-ups do not only get the body ready but the mind as well.

There is evidence that warm-up exercises affect swimming performance. The study of Arnett (2000) revealed that increased morning warm-up affected body temperature and swimming performance. In the study, she used ten athletes who warmed up in a standard volume (2,011.68 m) in the morning. Each participant completed one test condition per day. The study of Arnet (2000) points out that conducting warm-up exercise changes the body's autonomic state that includes increased temperature, heart rate and more packed cell volume in the blood. These autonomic responses were tested by Walker (1998) where he used a different system of warming up the body before swimming by increasing the said physiological responses. It was found in the study that after warm-up (1) the cell volume in the blood was significantly more packed, (2) white blood cell count and total plasma protein were significantly higher, (3) heart rate was significantly lower and (4) muscle activity were more efficient. It was further suggested that the intensity of exercise in the swimming pool was is strengthened after a warm-up exercise.

Method

Design

The study used a 2 X 2 factorial design based on a mixed model. The speed on different swimming skills was measured before and after the rehearsal learning (within groups). Warm-up exercises were conducted with a group of participants before swimming and the others did not undergo warm-up exercises (between groups).

Participants

The participants were 202 college freshmen students taking up their physical education class in swimming. The average body weight of the students is 148.27. The students participated as part of the course requirement in swimming.

Instrument

A stop watch was used to measure the students speed. The unit used in measuring time is the seconds completed by each participant. The speed was recorded for every swimming stroke performed. The measurement was taken after the stroke was demonstrated and after doing the rehearsal strategy.

Procedure

The different swimming skills were taught to the students. Before the students were instructed to go to the water for the demonstration of the swimming strokes, they have undergone warm-up exercises. The warm-ups included 16 sit-ups, front and back stretch, land running and water run. The other classes did not undergo warm-ups and they were directly taught the different swimming skills in the water. The swimming skills include the following:

- (1) flutter kick – moving the legs up and down in the water with a slight bent in the knee.
- (2) flutter kick with one arm breathing – one arm is extended doing a six beat kick and on the fifth kick where the thumb touching the thigh the swimmer bubbles or release air and on the recovery or at the highest peak of the arm the swimmer takes a big bite of air to breath.
- (3) back kick – back float position with hands on the side.
- (4) shoulder roll – kick on the back with hands on the sides on which after six beat shoulder is rolled alternately.
- (5) arms overhead with back kick – kicking on the back and arms are interlaced overhead.
- (6) breast kick with partner - one partner pulls in front while the other kicks in rear. Kicker holds on to feet of puller, switching at walls.
- (7) back float breast kick – floating on the back with a good full breast kick.
- (8) arms on waist

After teaching each of the eight swimming strokes, the participants were instructed to rehearse the stroke that was just taught in a repetitive drill for half of the class time (45 minutes) then the post measurement of their speed was measured. After the drills, the students were instructed to perform the stroke and a recorder is assigned to time their speed. The students before swimming were informed not to be conscious of the time while performing the stroke in the water. The pretesting of speed, rehearsal and post testing of speed was conducted in a 3 hour period within 8 sessions of the entire term.

Data Analysis

The Multivariate Analysis of Variance (*MANOVA*) was used to determine the effects of rehearsal learning and warm-up exercise on the swimming speed of the participants. Included in the *MANOVA*, the change of speed before and after the rehearsal learning was compared on the swimming speed in general and for each of the swimming skills in the univariate analysis. The group that received warm-up and the group that did not were also compared on the same dependent measures both as a whole and univariate analysis.

The Cohen's *d* was used to determine the effect size of rehearsal learning and warm-up on each of the swimming speed.

Results

The mean and standard deviation of the time of swimming of the participants were determined before and after the rehearsal and between the groups that did and did not undergo the warm-up exercise.

Table 1
Mean and Standard deviation of Time in Performing the Strokes

Factors	N	One Arm							
		Flutter Kick		with Breathing		Back Kick		Shoulder Roll	
		M	SD	M	SD	M	SD	M	SD
Total	202	21.56	10.16	19.35	7.85	23.59	8.87	26.19	9.51
Speed pretest	101	24.98	11.66	22.13	8.38	26.91	9.80	29.21	10.25
Speed posttest	101	18.14	6.92	16.57	6.17	20.28	6.32	23.17	7.65
No warm-up	92	22.85	12.77	20.82	8.85	25.24	10.59	26.78	9.00
With warm-up	110	20.48	7.19	18.13	6.71	22.22	6.87	25.69	9.94
Pretest no warm-up	46	27.17	14.60	24.09	8.91	28.87	11.97	29.67	9.67
Pretest with warm-up	55	23.15	8.17	20.49	7.61	25.27	7.23	28.82	10.79
Posttest no warm-up	46	18.52	8.86	17.54	7.56	21.61	7.53	23.89	7.29
Posttest with warm-up	55	17.82	4.80	15.76	4.64	19.16	4.90	22.56	7.95

Table 1. (Cont.)

		Arms Overhead with Back Kick		Breast Kick with Partner		Back Float Breast Kick		Arms on Waist	
		<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Total	202	25.50	10.07	31.43	11.66	30.21	12.03	28.93	9.19
Speed pretest	101	29.58	11.31	36.51	12.47	34.06	13.74	31.69	9.80
Speed posttest	101	21.41	6.49	26.35	8.11	26.36	8.49	26.17	7.64
No warm-up	92	26.03	10.41	32.82	11.55	31.01	13.12	31.09	9.97
With warm-up	110	25.05	9.81	30.27	11.68	29.54	11.05	27.13	8.10
Pretest no warm-up	46	29.28	11.94	39.70	12.28	34.93	15.34	35.17	10.34
Pretest with warm-up	55	29.84	10.86	33.85	12.10	33.33	12.35	28.78	8.36
Posttest no warm-up	46	22.78	7.40	25.93	4.70	27.09	9.03	27.00	7.75
Posttest with warm-up	55	20.25	5.41	26.69	10.15	25.75	8.04	25.47	7.54

The mean values from pre-test to posttest of time generally indicate a decrease in time. The same goes with the rehearsal where the group receiving it had lower means. The trend shown by the mean of speed was tested using the *MANOVA*. The *MANOVA* was performed to determine the overall effects of rehearsal and warm-up exercise on swimming speed in general through the Wilks Lambda.

Table 2
MANOVA Summary Table

	<i>Wilks Lambda</i>	<i>F</i>	<i>df</i>	<i>df Error</i>	<i>p</i>
Pre- and posttest	0.67	11.89*	8	191	0.00
warm-up	0.91	2.48*	8	191	0.01
Rehearsal x warm-up	0.94	1.58	8	191	0.13

* $p < .05$

The *MANOVA* performed on the overall swimming time indicates that there is a significant change in the speed of the swimming time from pretest to post test, $F(8, 191) = 11.89$, $p < .05$. The reported means show that for most of the cases the means significantly decreased from pre to post measurement of time. The difference between the group that received the warm-up and no warm-up was significantly different $F(8, 191) = 2.48$, $p < .05$. The computed means show that the time for the group that received warm-ups had lower time in performing the strokes as compared with the groups that did not undergo the warm-up.

Table 3
Univariate Analysis

Factors	Flutter Kick				
	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>P</i>
Rehearsal	1	2447.65	2447.65	26.96**	0.00
warm-up	1	280.45	280.45	3.09	0.08
rehearsal x warm-up	1	138.46	138.46	1.53	0.22
Error	198	17975.11	90.78		
One Arm with Breathing					
Rehearsal	1	1591.02	1591.02	30.20**	0.00
warm-up	1	361.97	361.97	6.87**	0.01
rehearsal x warm-up	1	41.31	41.31	0.78	0.38
Error	198	10432.74	52.69		
Back Kick					
Rehearsal	1	2238.90	2238.90	33.79**	0.00
warm-up	1	457.20	457.20	6.90**	0.01
rehearsal x warm-up	1	16.60	16.60	0.25	0.62
Error	198	13120.60	66.30		
Shoulder Roll					
Rehearsal	1	1814.70	1814.70	22.06**	0.00
warm-up	1	59.70	59.70	0.73	0.40
rehearsal x warm-up	1	2.80	2.80	0.03	0.85
Error	198	16292.30	82.30		
Arms Overhead with Back Kick					
Rehearsal	1	3239.20	3239.20	38.08**	0.00
warm-up	1	48.80	48.80	0.57	0.45
rehearsal x warm-up	1	119.00	119.00	1.40	0.24
Error	198	16841.10	85.10		
Breast Kick with Partner					
Rehearsal	1	5483.80	5483.80	51.11**	0.00
warm-up	1	323.90	323.90	3.02	0.08
rehearsal x warm-up	1	545.10	545.10	5.08*	0.03
Error	198	21245.10	107.30		
Back Float Breast Kick					
Rehearsal	1	2981.80	2981.80	22.72**	0.00
warm-up	1	108.90	108.90	0.83	0.36
rehearsal x warm-up	1	0.90	0.90	0.01	0.93
Error	198	25989.00	131.30		
Arms on Waist					
Rehearsal	1	1651.50	1651.50	22.78**	0.00
warm-up	1	785.50	785.50	10.83**	0.00
rehearsal x warm-up	1	296.40	296.40	4.09*	0.04
Error	198	14357.7	72.5		

* $p < .05$

The univariate analysis shows the individual effects of rehearsal and warm-up exercise on the different swimming strokes. For flutter kick, shoulder roll, arms over head, and back float breast kick, the pre and post measurement of time is significantly different where time

decreased after the rehearsal, $p < .05$. For one arm with breathing and back kick, the differences are between pre and post test of time and between the group with warm-up and without warm-up are significant. For breast kick with partner, pre and post measurement of time for rehearsal is significant and there is a significant interaction between rehearsal and warm-up exercise, $p < .05$. For arms on waist, all sources of variation are significant, $p < .05$.

The effect size of rehearsal and warm up is computed using Cohen's d . The effect size indicates how large the effects are of the two treatment conditions on each of the speed in performing the swimming strokes.

Table 4
Effect Size for each Swimming Stroke

Swimming Strokes	Effect Size of Rehearsal	Remark	Effect Size of Warm-up	Remark
Flutter Kick	0.74	medium	0.23	small
One Arm with Breathing	0.76	medium	0.34	small
Back Kick	0.8	large	0.34	small
Shoulder Roll	0.68	medium	0.11	small
Arms Overhead with Back Kick	0.92	large	0.09	small
Breast Kick with Partner	0.96	large	0.22	small
Back Float Breast Kick	0.67	medium	0.12	small
Arms on Waist	0.63	medium	0.44	small

The effect size results show that for the rehearsal, the effect is from medium to large. Specifically, back kick ($d=0.8$), arms overhead with back kick ($d=0.92$) and breast kick with partner ($d=0.96$) have large effect sizes. The pattern of the large effect size shows that most of the strokes have the kicking component. For warm-up exercise, small effect sizes were found on all swimming strokes.

Discussion

The results indicate that rehearsal has a significant effect on the time of performing the different swimming strokes in general where there is a decrease in the time from pre-test to posttest. This can be explained by the benefits that rehearsal can give on performing a task. The results demonstrated that the practice effects of rehearsal on swimming increases speed (Weiss, McCullagh, Smith, & Berlant, 2000). It supports the findings of Harris (1943), Humphrey (1933) and Kandel (1976) which proved that rehearsal decreases the response to learning. It was explained by Brown, Frost and Getting (1996) that habituation and iterative enhancement of a task indeed increases response such as swimming which supports the results for the present study. Nevertheless, the intensity provoked by the rehearsal was not

varied in the study. It can be noted that medium to large effect sizes were found where large effects sizes were on swimming strokes that involved kicking. Kicking in the water for several times increases further skills which were demonstrated in the results where a large difference in the time for these strokes was found.

The results indicate that warm-up exercises significantly affects the time of performing the different swimming strokes in general where the group receiving the rehearsal learning had faster time in performing the swimming strokes. Through warm-up exercises, the body's condition to perform a task is heightened (Whitten, 1994). The results support the findings of Arnett (2000) and Walker (1998) which showed that swimming performance is affected when the body's temperature is increased with some stretching. As compared with the effect sizes of rehearsal, warm-up exercises had small effect sizes on the different swimming strokes.

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