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EFFECTS OF AQUATIC TRAINING ON SWIMMING SKILL DEVELOPMENT OF PRESCHOOL CHILDREN[1]

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Summary.—This research investigated the effects of aquatic training on the swimming performance of 126 children, ages 2.5 to 5.5 yr., over 8 mo. Two groups of children were enrolled in an aquatic training program. Group 1 were returning program participants at the beginning of this study, and Group 2 were new participants. The control children (Group 3) received no aquatic training during the research. Subjects performed six categories of swimming tasks at three points in time—1st mo., 4th mo., and 8th mo. The categories were Locomotion: Front, Locomotion: Back, Kicking, Entry: Jump, Diving, and Ring Pick-up. A 2 × 3 × 2 × 3 (sex × group × age × time) repeated-measures analysis of variance procedure showed that returning participants performed each category of swimming tasks at a more advanced level than the other groups at each time of measurement. New participants after training performed five of the categories of tasks at a more advanced level than the control group. Amount of training significantly influenced swimming, and training effects were task-specific when data were interpreted in terms of specific movement characteristics.

This research investigated the effects of aquatic training on the swimming skill development of young children. Historically, several motor-development researchers have studied the development of swimming skills of children. In a classic study, McGraw (1939b) described the sequential development of prone swimming during infancy. She observed that there were three phases of swimming in infants: reflexive, disorganized, and voluntary. Each phase had unique movement characteristics attributed to the underlying development of the central nervous system. More recently, Erbaugh (1981) described longitudinal changes in the swimming behavior of preschool children. She found that six specific swimming characteristics improved significantly between the ages of 3.5 yr. and 5.0 yr.: arm movements, leg movements, body position, head position, distance travelled, and independence. Also, leg and arm movements developed sequentially in the prone swimming behavior of preschool children. The primitive form was leg-dominated, whereas the refined stroke incorporated an overarm pattern.

The previous research of McGraw, Erbaugh, and other scholars has focused primarily on the description of swimming behaviors of infants and children

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(Diem, 1974; Demarest, 1979; Oka, Okamoto, Yoshizawa, Toluyama, & Kumamoto, 1978), and only limited research concerned the explanation of the observed changes in swimming skills of children or the determinants of behavioral change (Baltes & Goulet, 1970; Wohlwill, 1973). McGraw (1939a) observed the swimming behavior of Johnny and Jimmy at school age following training during infancy. Johnny who received weekly training during the first 17 mo. of life swam in a horizontal position using a well-coordinated front crawl pattern at six years, whereas Jimmy who received no training swam in a vertical position using a rather primitive dog-paddling pattern. Johnny also had more self-confidence in his performance of physical skills than did Jimmy.

McGraw (1935) also observed the diving skill development of Johnny during infancy. She reported that he began to dive five months later than he began to swim, and that he became a proficient diver after 3 mo. of training. Diem (1982) examined the effects of swimming training on German children's total development between four and six years. The swimming training during infancy and early childhood resulted in superior levels of personal/social development and motor development in 4- to 6-yr.-olds. Children who received early training had greater motivation and more self-confidence than the control children. The trained children also exhibited higher levels of movement quality, movement accuracy, balance, and reaction ability than did the control children (p. 25).

The training research of McGraw (1935, 1939a, 1939b) and Diem (1982) suggested that aquatic instruction during infancy and early childhood significantly influenced the quality of swimming and diving skills. Aquatic training also promoted a positive attitude about swimming. One limitation of this research was that children's specific swimming characteristics were not described after training. Another limitation was that McGraw's insights about long-term training effects were speculative because she was unable to observe Johnny and Jimmy's behavior systematically during the preschool years.

This research examined the effects of an aquatic training program on the swimming performance of children, ages 2.5 yr. to 5.5 yr., over an 8-mo. period. The swimming performance of three groups—two experimental and one control —were assessed at three points in time—Mo. 1, 4, and 8 (Times 1, 2, and 3). The major hypothesis was that children in the first experimental group with previous training at Time 1 would perform at a more advanced level than either of the other groups at each point in time. The next hypothesis was that the second experimental group who began aquatic training at Time 1 would perform at a more advanced level than the control group at Times 2 and 3. Previous research indicated that age and sex also were factors which might influence children's swimming performance (Erbaugh, 1980, 1981) so they were included in the design.

METHOD

Subjects

Subjects were 126 preschool-aged children (63 boys, 63 girls) from a Midwestern university-centered community. The two groups of trained children were participants in the Purdue Developmental Movement Education Program. Parents, most of whom were University faculty or graduate students, voluntarily enrolled their children. Group 1 ($n = 32$) were returning children with a mean age of 4.3 yr. ($SD = 0.7$ yr.) and an average of 2.5 semesters of previous aquatic training at Time 1. Group 2 ($n = 30$) were newly enrolled children whose mean age was 3.6 yr. ($SD = 1.2$ yr.) and who had no previous aquatic training. The third group were control subjects from the same community whose parents voluntarily allowed them to participate. Group 3 ($n = 64$) whose mean age was 3.7 yr. ($SD = 1.1$ yr.) had no previous formal swimming instruction. They also were not enrolled in swimming programs during this research. All parents were informed about testing procedures prior to the study, and they consented to their child's participation.

Measurement

The Erbaugh rating scale which has six categories of swimming tasks was used to assess the swimming performance of the children. Table 1 presents the general descriptions of each category: Locomotion: Front, Locomotion: Back, Kicking, Entry: Jump, Diving, and Ring Pick-up. The tasks in each category which were arranged by order of difficulty have been presented elsewhere (Erbaugh, 1981).

The reliability and validity of the scale were established with 57 children in previous research (Erbaugh, 1978). Intraclass correlations were used to estimate interjudge objectivity, intertrial consistency, and stability across days. Correlations were $\geq .98$, $\geq .96$, and $\geq .90$, respectively. Pearson product-

TABLE 1

DESCRIPTIONS OF SIX CATEGORIES OF SWIMMING TASKS*

1. Locomotion: Front: Maintain a prone position and propel self with or without the assistance of an examiner or flotation device, 14 tasks.
2. Locomotion: Back: Maintain a supine position and propel self with or without the assistance of an examiner or flotation device, 15 tasks.
3. Kicking: Maintain prone position and propel self using legs only, with or without the assistance of an examiner or flotation device, 14 tasks.
4. Entry: Jump: Enter pool foot first by climbing down ladder or jumping into the water and propelling self to the examiner, 18 tasks.
5. Diving: Enter the pool head first, and propel self to the examiner, 3 tasks.
6. Ring Pick-up: Stand independently in shallow (chest deep) water and grasp a ring placed near the feet, 4 tasks.

*From Erbaugh (1978, p. 1180).

moment correlations were computed for data of 19 children to estimate the interjudge objectivity of the two raters used in this research (investigator, another faculty member). Correlations were $\geq .98$. These values are thought to be acceptable. The categories of swimming tasks in the scale have logical validity based on the task selection procedures which have been described elsewhere (Erbaugh, 1978, 1980, 1981).

Procedure

Standardized testing procedures were used to assess the swimming skills of each child. A judge and an adult swimmer (examiner) tested children individually at Times 1, 2, and 3 (Sept., Dec., and April). The adult swimmer asked the child to perform at least two trials of each category of tasks during a 20-min. session. The judge who sat on the pool deck rated the child's performance of each category of swimming tasks. Other experimental procedures have been presented by Erbaugh (1981).

The pool dimensions were 18.6 m $\times$ 9.30 m, and the depth was 1.24 m to 1.86 m. This depth was appropriate for five of the categories of tasks. The Ring Pick-up tasks were performed on a 1.86-m $\times$ 1.86-m submerged platform. The temperature of the water and the room were 86° and 90°, respectively.

Aquatic training.—All trained children were enrolled in the movement program during this research. Enrollment was voluntary and children became eligible at the age of 2 yr. Children received 20 biweekly swimming lessons of 30 min. each during the semester. The teachers were undergraduate students with Water Safety Instructor certificates. Instruction was individualized because each child had his own teacher. The pool program emphasized the use of perceptual-motor tasks; therefore, a variety of nontraditional equipment was used to encourage a child's performance. For example, a child might be asked to swim through a submerged hula-hoop to promote total head submersion. Finally, teachers kept detailed records of individual progress and of their instructional plans. Additional information has been presented by Erbaugh (1981) and Clifton (1970).

RESULTS

A four-factor, 2 $\times$ 3 $\times$ 2 $\times$ 3 (sex $\times$ group $\times$ age $\times$ time), repeated-measures analysis of variance was applied to mean performance of the children on each category of swimming tasks. Only two-factor interactions were examined given sample characteristics. *Post hoc t* tests were used to provide additional information about swimming-skill development during the 8 mo. of training (Dixon & Brown, 1981).

Table 2 presents the mean swimming performance of the aquatic training groups for the six categories of tasks: Locomotion: Front, Locomotion: Back, Kicking, Entry: Jump, Diving, and Ring Pick-up. The group $\times$ time within-

TABLE 2

MEAN PERFORMANCE OF AQUATIC TRAINING GROUPS AT EACH MEASUREMENT

Categories of Swimming Tasks	Groups*	Time 1		Time 2		Time 3	
		M	*SD*	*M*	*SD*	*M*	*SD*
Locomotion: Front	1	6.6	3.4	9.2	3.2	10.7	2.9
	2	2.8	3.5	7.0	3.2	7.8	3.6
	3	3.0	3.0	3.4	2.8	3.9	2.8
Locomotion: Back	1	5.7	4.1	8.2	4.1	9.8	4.2
	2	2.3	2.7	5.1	3.6	6.5	4.3
	3	2.3	2.8	2.8	2.6	3.1	3.0
Kicking	1	8.0	3.0	9.6	3.0	10.8	2.7
	2	3.3	4.1	7.3	3.7	8.1	3.5
	3	3.0	2.9	4.3	2.9	4.5	3.1
Entry: Jump	1	4.6	5.1	11.5	4.9	13.2	4.7
	2	4.3	4.2	7.8	5.5	9.1	5.1
	3	3.7	3.6	4.7	3.6	5.5	3.9
Diving	1	0.8	1.1	1.2	1.1	1.6	1.3
	2	0.1	0.4	0.5	0.9	0.6	1.0
	3	0.2	0.5	0.2	0.6	0.2	0.6
Ring Pick-up	1	1.8	1.4	2.4	1.3	2.9	1.2
	2	0.6	1.0	1.5	1.6	1.8	1.5
	3	0.4	0.8	0.6	1.0	0.7	1.1

*Groups: 1: Returning participants ($n = 32$), 2: New participants ($n = 30$), 3: Control subjects ($n = 64$).

subject interaction was statistically significant ($p < .01$) for each category, and the other two-way interactions were nonsignificant ($p > .01$). There were group differences in performance due to training; however, the aquatic training effects were not influenced by age or sex.

Post hoc t tests indicated there were significant differences ($p < .01$) between the swimming performance of Groups 1 and 2, and 1 and 3 at each point in time for children's performance of each category of tasks (Hypothesis 1). For Locomotion: Front, for example ($F_{2,228} = 29.5, p < .01$). As shown in Table 2, the means for Groups 1—returning participants, and 2—new participants at Time 1 were 6.6 and 2.8, respectively. The means for the same two groups at Times 2 and 3 were 9.2 and 7.0, and 10.7, and 7.8, respectively. This finding suggested that aquatic training had a significant effect on the swimming performance of the returning participants (Group 1) because they maintained their superior performance levels on the six categories of swimming tasks throughout the 8-mo. period.

Post hoc tests also indicated there were significant differences ($p < .01$) between the swimming performance of Group 2—new participants, and Group 3—controls at Times 2 and 3 for each of the task categories except Diving

(Hypothesis 2). For Locomotion: Front, for example, the means for Groups 2 and 3 at Time 2 were 7.0 and 3.4, and at Time 3, they were 7.8 and 3.9, respectively. This finding suggested that the aquatic training program had a significant effect on the swimming performance of the new participants (Group 2). Their performance on five of the task categories improved rapidly during their first 8 mo. of instruction whereas the performance of the control group did not improve.

Discussion

First, the results for each of the six categories of swimming tasks provided evidence that the amount of aquatic training significantly influenced children's performance over an 8-mo. period. Children with approximately one year of previous instruction at Time 1 performed all categories of swimming skills at a more advanced level at each time of measurement than children in the other groups with no previous aquatic instruction at Time 1. Next, the results indicated that the swimming skills of preschool children are extremely sensitive to training. Children enrolled in the training program at the beginning of this research made significant improvements after instruction in five of the six categories of swimming tasks. In contrast, children who received no instruction did not improve. These general findings verify several of McGraw's (1939a) views about development of swimming skills during the preschool years: (a) early training improves the quantitative and qualitative aspects of performance and (b) the preschool years are sensitive years for motor skill acquisition. Finally, the results indicated that the development of diving skills were delayed during the preschool years. Children performed the most advanced diving task only after two years of previous aquatic training. This observation was similar to previous research (Erbaugh, 1981; McGraw, 1939a).

The mean swimming performance of the aquatic training groups for several of the categories (Table 2) were interpreted in terms of the original scale values to provide specific information about the effects of aquatic training on the movement characteristics (Erbaugh, 1981, pp. 197-214). On Locomotion: Front tasks, preschool children with two semesters of aquatic training (Group 1 at Time 1) were able to propel themselves independently using a human stroke for a distance of approximately 2 m ($M = 6.6$). After three semesters of aquatic training, they were able to submerge their heads intermittently, and they began to use a flutter-kick leg action ($M = 9.2$). After four semesters of training, they used a rudimentary front crawl pattern to propel themselves at least 3 m ($M = 10.7$). Their flutter-kick leg action was fairly efficient, however, their arm action was rudimentary and their breathing techniques were unrefined. These children preferred to lift their heads above the water to inhale *and* exhale. In contrast, the children with no aquatic training (Group 2 at Time 1) were unable to swim independently (M

= 2.8). They pushed-off the platform and glided a distance of 1 m to the examiner using a pedaling leg action with limited propulsive effects. After one semester of training, these children exhibited swimming characteristics that were similar to those of Group 1 at Time 1 (M = 7.0). After the second semester, there was very little change in performance over the previous time of measurement (M = 7.8). The control children had characteristics similar to those of Group 2 at Time 1 (M = 3.0) and they did not improve. This description of prone swimming as a function of amount of aquatic training clearly illustrates the importance of instruction during the preschool years. On the average, one year of instruction is needed before children are able to swim independently using a human stroke, and two years are needed for development of a rudimentary front crawl. It also was of interest that the flutter kick emerged approximately 3 mo. prior to the overarm action. This specific information about intratask sequences is in agreement with Erbaugh (1981, p. 151). Additional research in this area may extend the level of knowledge about motor development.

On Locomotion: Back tasks, children with two semesters of aquatic training were able to propel themselves with the support of a belt a distance of 2 m (M = 5.7) using finning arm movements and a rudimentary flutter kick. After three semesters of training, they increased their distance to 3 m using the same movement patterns. Only after four semesters of aquatic training were the children able to propel themselves independently in a supine position for a distance of 2 m (M = 9.8). In contrast, children with no aquatic training (Group 2 at Time 1) were unable to maintain a supine position without the support of the examiner (M = 2.3). They were tense when placed in a supine position and kept their heads above the water. After one semester of training these children became more relaxed, however, they were still fairly dependent on the examiner (M = 5.1). After the second semester, this group performed at a level similar to that of the returning children at Time 1 (M = 6.5). The control children found Locomotion: Back tasks very difficult throughout the study (Ms = 2.3, 2.8, and 3.1). The description of supine swimming of the training groups showed the importance of instruction. On the average, two years of instruction was required before children are able to swim independently. It was of interest that the children performed the Locomotion: Front tasks at a more advanced level than the Locomotion: Back tasks. Erbaugh (1981) reported similar intertask differences in previous research. At present, the explanation remains unclear.

Finally, on Diving tasks, 50% of the children were unable to perform a standing dive (M = 1.6) after four semesters of aquatic training (Group 1 at Time 3). In contrast, 20% of the new participants were able to dive after two semesters (Time 3). On the average, two years of aquatic training are necessary for mastering a standing dive.

In summary, this research provides information about the effects of aquatic training on the swimming skill development of preschool children. Their performance on each of the six categories of tasks improved as the result of training over the 8-mo. period. The length of training also was a factor. After two semesters, children were able to swim independently in a prone position, and after four semesters the quality of their movements improved tremendously. This research also suggested that training effects are task-specific. At the end of training, children were more proficient on the Locomotion: Front tasks than they were on the Locomotion: Back tasks, and they were least proficient on Diving tasks. This conclusion is in agreement with the classic training research of McGraw (1939a). Additional research is needed to explain these intertask developmental differences.

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