

Descriptions of the Leg Movements of Infants in an Aquatic Environment

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The majority of research concerning the mechanics of swimming has been confined to competitive swimming strokes of males and females over the age of 10 yr. With the increased emphasis on teaching children to swim during infancy, there is a need to investigate infants' swimming patterns. The purpose of this study, therefore, was to describe the movement patterns for the lower limbs of infants aged 3-20 months as they propelled themselves in the water under different support conditions. It was felt that this might provide a greater understanding of the natural evolution of aquatic movement patterns and help in developing guidelines for manipulation of the learning environment (Wielki, 1980).

Procedures

The study took place over a period of 4 yr, with 40 infants as subjects. These infants participated in aquatic activities in a specially conditioned pool at Universite Catholique de Louvain at Louvain-La-Neuve, Belgium.

Observations were made in weekly classes grouped by age, each session lasting 30 min in the water at a temperature of 32°C. All infants required support of some type: a parent or a floating appliance. The infants' behavior was studied using two methods: (a) *Direct observation* of each infant's movements were recorded on an observation form; and (b) *indirect observations* were made through underwater videotaping or by using a 16-mm camera. Each infant passed in front of the camera during these aquatic activities.

In general, these two methods recorded the infants in three positions: vertical, prone and supine. These methods of analysis permitted a study of the infants' behavior, an analysis of the lower limb gestures and even

an attempted classification of the motor actions. These observations were specifically designed to be carried out in a natural context rather than in a laboratory situation. Patterns of similar action by the lower limbs were identified and placed into classification types and stages. Tracings were made from stop-action viewings in order to depict each pattern.

Results of Observations

Taking into consideration both the direct and indirect observations, some general remarks on the evolution of infants' motor actions in this study are given initially. First, development of the infants' movements in the water was very diversified; each infant progressed at its own rate, just as in other normal physical activities. Development of the infants' behaviors in different aquatic situations was influenced by many factors. Among these, the most influential seems to be the age at which the infant began the aquatic experience. Each age group had a characteristic level of aquatic motor skills, but individual variations were quite evident. After having analyzed the lower limb motor actions of 40 infants, it was possible to distinguish two stages of development. These stages will be discussed in the remainder of this article.

First Stage: Movements of Infants Aged 3-11 Months

These were considered reflex-bound movements since they occurred immediately upon the presentation of the stimulus (e.g., placement in a new position or presentation of a toy). These movements were "violent" and random in nature. In this first stage, it was possible to classify the lower limb motor actions into four types. *Movement similar to a "cigarette lighter"* (Figure 1) was observed in infants aged 3, 4 and 5 months. In an action that alternates, the toes of one foot rub against the opposite leg. This behavior appears to be innate and manifests itself mostly in the vertical position; however, it has been observed in the prone and supine positions as well.

Alternating flexion and extension of the leg (Figure 2) was seen at a constant speed or with a certain tempo. This seems to be an innate, coordinated reflex; no forward efforts could be observed. As in the "cigarette lighter" type, this behavior was noted in infants up to the age of 5 months and most often in the vertical and prone positions. These two types of motor action observed as a part of the aquatic activities of infants aged 3-5 months were considered archaic reflexes, made in response to the outside environment such as water pressure, temperature, etc.



Figure 1—"Cigarette lighter" movement.

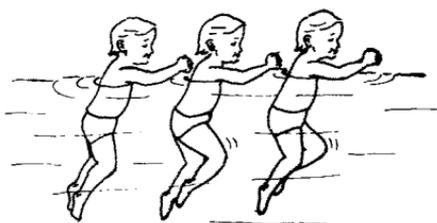


Figure 2—Alternating reflex leg movements.



Figure 3—Simultaneous kicking movements of the legs.

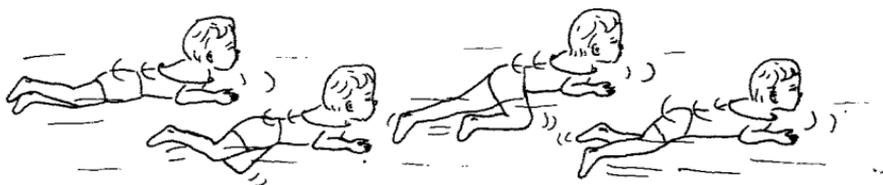


Figure 4—Alternating kicking movements of the legs.

Simultaneous flexions and extensions of the leg (Figure 3) were shown in the behavior of infants 5-10 months old. This motor activity consisted of 2-4 repetitions of flexion and extension movement. Between each series of movements, there was a brief interlude of inactivity. In some infants, one can observe an undulating movement of the body accompanying this series of movements.

The fourth type of action observed was *alternating flexions and extensions of the leg* (Figure 4). This motor activity can be characterized the same way as the previous type: a series of rapid and rhythmic flexions and extensions of the legs, with the added distinction that one leg extends with more force or speed than the other.

For these last two actions, involving simultaneous and alternating kicking, it was postulated that the infant expresses its affective state toward its mother or its emotional state toward the aquatic environment, a toy, etc. These reactions were observed in more than 80% of the infants near the age of 5 months and often in both prone and vertical positions. Since these reactions disappear toward the age of 10 months, it is likely that these reactions also are reflex-bound.

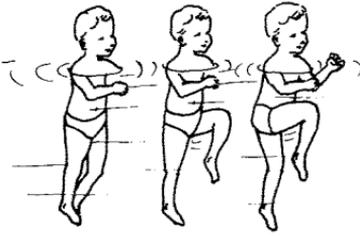


Figure 5—Movement of the legs:
The knee flexes forward.

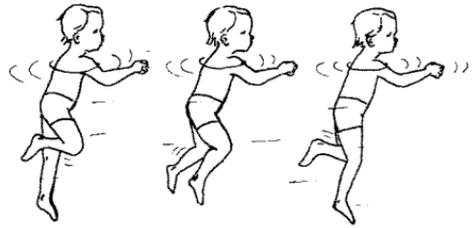


Figure 6—Movement of the legs with the
lower leg behind.



Figure 7—“Bicycle” movement.

Second Stage: Appearance of Alternating Leg Movements

This stage was seen in infants aged 11-20 months, and was considered voluntary. In the second stage, “voluntary” alternating movements of the legs appear. We distinguished three types of propulsive movements which progressively developed into a bicycle movement.

Alternating movements of the legs: lifting of the leg and extension of the foot (Figure 5). The infant, in a vertical position, carries the leg forward and flexes the knee at the same time. Then he or she pushes the leg downward, maintaining an extended foot. The extension of one leg, coordinated with the flexion of the other, permits the infant to move slowly forward. It is the first appearance of forward propulsion and manifests itself near the age of 11-12 months.

Alternating movements of the legs: The knee flexes but remains in place as the lower leg goes backwards (Figure 6). The infant, in a vertical position, obtains propulsion by alternately flexing the knees. After flexion, the leg is brought back to a vertical position. This rhythmic and coordinated movement permits the infant to progress forward more rapidly than the previous action because the sole of the foot is used. This type of propulsion was observed in infants near the age of 12-13 months.

Alternating movements of the entire lower limbs (Figure 7). Using a combination of the first two movements in this group, the infant begins to simulate a “bicycle” motion with the legs. Being in a vertical position, the infant gradually demonstrates a more efficient means of propulsion

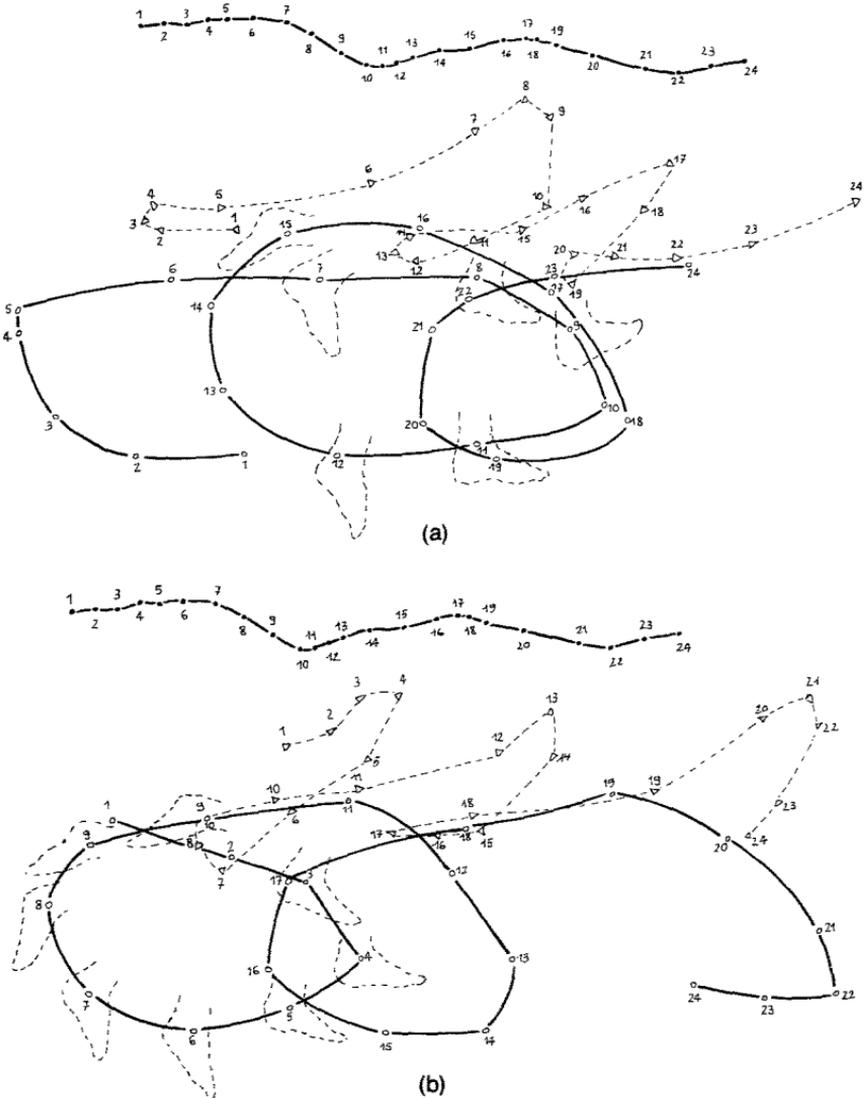


Figure 8—Positions of (a) right and (b) left lower limbs in the bicycle movement. —○—, progressive motion of the ankle joint; —△—, the knee joint; —●—, the hip joint.

by flexing the leg in front of the body, then reaching forward to increase the “hold” on the water in front of the body. He or she then pushes the water backward, executing a “bicycle” movement.

In this type of movement, the infant has included movement of the foot, resulting in a more rapid and constant progression forward through the use of the ankle joint. This movement is more coordinated and the alternate leg movements become more symmetrical. To illustrate this

type of movement, a trace is shown in Figure 8. The infant is in the vertical position supported by the mother and facing her.

Conclusion

Infants' lower limb actions in an aquatic environment may be divided into two stages and seven types. Since the younger children exhibited patterns of a reflex-bound nature (McGraw, 1943), these may be considered to be stage 1 types. Stage 2 types seemed to be of a voluntary character (McGraw, 1943).

These stages and types occur in a variety of supportive situations. The influence of the manner in which support is provided to the infant has not been analyzed. The relationship of manner of support to type of lower limb movement patterns needs to be determined. In our opinion, an infant after passing these two stages of development is able to cope with the aquatic environment and to develop skills within the confines of the situation introduced in the aquatic activity.

References

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