

## Psycho-Motor Skills in Swimming Among Children: Gender Differences

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**Abstract:** *Psychomotricity is a broad term that encompasses different approaches to bodily action to support children and adolescents to reach their highest motor and cognitive potential. The aim of the study was to highlight gender differences in the manifestation of psychomotor behaviors in 8–9-year-old children who practice sports swimming. The subjects (N=52, 26 males, 26 females) are children aged 8.0-9.11 years (M = 8.80; SD = ±0.65) who practice swimming in one of the swimming pools of a city in Romania. They were tested, using specific instruments, to assess the level of manual dexterity, body schema, hand laterality, body balance, body balance on water/buoyancy, general coordination. For four of the variables (manual dexterity, body schema, hand laterality and spatial orientation) no statistically significant differences were found, while for the other three (body balance, body balance on water and general coordination) statistically significant differences were recorded. The results indicate differences between the two genders, girls in this age group who practice swimming having more developed psychomotor skills compared to boys.*

**Keywords:** *psychomotor behaviors, swimming, children, gender.*

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## 1. Introduction

The term *psychomotricity* is derived from the two words: *psycho*, which refers to the cognitive and emotional areas, and *motricity*, which focuses more on the physical and motor aspects, combining both to create a duality-based approach where the body and his actions become the vehicle through which the person moves, knows, relates and feels (Berruezo, 2008).

*Psychomotricity* as a concept is not easy to explain, although it is generally understood as a tool that aims to promote the adequate development of motor, cognitive, emotional and socio-community skills, Făgăraș et al. (2014); Mota et al. (2020). On the other hand, this term can be understood either as a field with its own identity, or as a stimulation technique through bodily action, or as a (re)education technique (Denche et al., 2022).

One of the broadest definitions of psychomotricity was offered by the European Psychomotricity Forum, Paris Declaration of 2014: "based on a global view of the human being, on the unity of body and mind, psychomotricity integrates cognitive, emotional, symbolic and physical in the individual's ability to be and act in a psychosocial context" (Mota et al., 2020; Denche et al., 2022).

The interest in motor behavior is high, especially since there are certainties regarding the positive influence in the first years of life, up to 11-12 years (Albu & Albu, 1999). The link between psychomotor skills and playing/learning sports, including swimming, is also being researched.

In this study, we started from certain questions that were generated by the practical activity at the swimming pools in the Municipality of Iași:

- *what are the gender differences in the manifestation of psychomotor behaviors among children who practice swimming?*
- *do girls have a better level of manifestation of psychomotricity compared to boys?*

Through this research we measured the level of psychomotor behaviors (manual dexterity, body schema, hand laterality, body balance, body balance on water/buoyancy, spatial orientation and general coordination) on a sample of 52 subjects (26 girls and 26 boys), aged between 8.0-9.11 years old, practicing sport swimming at a swimming pool in the Municipality of Iași, Romania. We noticed the differences between girls and boys.

## 2. Materials and Methods

### 2.1. *The variables of the research*

The independent variable in the study was gender, male and female. We have used the following variables from the area of psychomotricity, as dependent variables: manual dexterity, body scheme, hand laterality, body balance, body balance on water/buoyancy, spatial orientation, general coordination.

*The manual dexterity* is the ability to perform precise and coordinated movements of the fingers and hand to manipulate objects, it relies heavily on the appropriate interaction between sensory and motor function, Knobbe et al. (2022).

On the other hand, it is a psychomotor skill by which small muscle groups are coordinated in performing movements that usually involve the synchronization of the hands and fingers with the visual analyzer - the eyes, (Kuloor, 2021). So, it can also be considered eye-motor coordination.

In swimming, manual dexterity is manifested in the active phase of the upper limb when the hand grasps, pulls and pushes the water. Petrea et al. (2023) identified a positive correlation of moderate intensity of manual dexterity with two of the technical styles (front crawl and backstroke).

*The body schema* is understood as an image or mental representation of one's own body and its differentiation from space and surrounding objects, in various static or dynamic situations. It is permanently reconstructed under the influence of the information flow of the exteroceptive, interoceptive and proprioceptive systems, concretely perceived and analyzed in different cognitive, affective, relational and social registers (Epuran, 2013).

Intentional motor actions depend on the representation of the body at the level of the central nervous system (mental representation of the body), and body schema disturbances have been presented in various studies as the main subject for motor impairments (Matsumiya, 2022). Without the body schema, we would not be able to accurately and safely control our body parts. Indeed, damage to the body schema leads to a variety of disorders, from motor dysfunctions to delusions that the affected body part belongs to another person (Haggard & Wolpert, 2004; Ota et al., 2018).

In swimming, the body scheme is considered an important goal of psychomotor development that will be of great use in this instructive-educational process. Through it, children will be able to perform various acts and motor actions in the aquatic environment (Petrea et al., 2023).

*The laterality of the hand.* In the literature, the concept of laterality is defined as the predominance of one or the other of the two symmetrical

devices - one hand, one eye, which determines the manual or ocular left- or right-handedness (Pieron, 2001).

Lafon (1969) defines laterality as the functional inequality of a part of the body as a consequence of the difference in development and distribution of functions in the cerebral hemispheres. It is basically the functional dominance of one part of the body over the other.

Behavioral preference for using a body part begins in prenatal life and causes people to develop motor asymmetries. The type of motor task performed influences those functional asymmetries (Bondi et al., 2020).

In swimming, laterality can be shown by a better execution technique or a greater efficiency in the rowing process of one segment compared to the other. For example, the right-hand paddles more efficiently than the left hand or vice versa. This can also happen in the lower limbs, and the effect of these actions is manifested by oscillations of the body from the direction of travel. Also, laterality can be important when the child is learning to breathe in the collar on the chest procedure. Most of the times, turning the head to breathe (inhale) is done, in the learning stage, on the side where the upper limb is dominant (on the side with the dominant hand).

*The body balance* or postural control can be defined as the ability to maintain a base of support with minimal movement and the ability to perform a task while maintaining a stable posture (Daneshjoo et al., 2012). Effective postural balance not only reduces the risk of body imbalance, falls or subsequent injury, but also contributes to the optimization of motor performance in several sports (McGuine et al. 2000; Hrysomallis, 2007). In swimming, static balance is positively associated with learning swimming styles, front crawl and backstroke (Petrea et al., 2023).

*The balance of the body on water (buoyancy)* consists in the stability of the human body in a position of horizontal floating (facial or dorsal) on the water, without any movement until the moment when the center of gravity of the body descends in the water which causes the feet to sink (McLean et al., 2000; Yanai & Wilson, 2008).

There are studies, McLean & Hinrichs (1998) in which the balance of the body on water was examined according to the gender of the subjects, and the results show us that female persons have the ability to float horizontally better compared to male persons.

In swimming, buoyancy is a very important predictor for the learning stage (Petrea et al., 2023), but also for achieving sports performance (Yanai & Wilson, 2008). Petrea et al. (2023) identified strong positive associations of buoyancy in swimming learning.

*The spatial orientation.* Spatial structuring is the ability to perceive, relate, move and orient ourselves in a certain space. The importance of spatial perception is essential in human development, in the sense that one can observe the shapes, structure or compositions of objects, as well as their location in relation to one's own person or to those around us (Bălăneanu et al., 2022).

In the practice of swimming, the spatial orientation skill is important for keeping the stroke on a straight waterline between the two beacons that delimit the swimming lane.

*The general coordination.* To produce correct motion, it is believed that the different degrees of freedom at each spatiotemporal scale should be coordinated. This issue has been examined from several perspectives in motor control, Bruton & O'dwyer (2018); Profeta & Turvey (2018).

Motor coordination comprises the synchronization of the nervous and musculoskeletal systems, resulting in a rapid, precise and balanced motor response, normally assessed by measures of hand-eye or eye-foot coordination, Corbin et al. (2000); Lopes et al. (2012).

Practicing swimming requires a good level of coordination in the body segments (upper limbs, lower limbs) as well as the whole body as a whole. The association of strong intensity between general coordination and execution technique of swimming styles has been highlighted, Petrea et al. (2023).

## ***2.2. The research method and tools***

To carry out this research, we used the observation method (participatory observation).

The research tools used were presented in Table 1 for each research variable separately.

**Table 1** *Research variables*

Variable	Type	Testing method
1. Manual dexterity	Dependent, Invoked	„Tapping” test
2. Body schema	Dependent, Invoked	Goodenough test
3. Hand laterality	Dependent, Invoked	Throwing at the target
4. Body balance	Dependent, Invoked	Flamingo test
5. Body balance on water	Dependent, Invoked	Horizontal buoyancy test (front crawl and backstroke)
6. Spatial orientation	Dependent, Invoked	Matorin test
7. General coordination	Dependent, Invoked	Arm spins + jumps + Matorin test
8. Gender	Independent, Invoked	Male, Female

*The author created the table, according to the data collected in our study and statistics used to analyze data.*

### **2.3. Research objectives**

*The main objective of this research study is to highlight the differences in the manifestation of psychomotor behaviors in children aged 8.0-9.11 years who practice sports swimming, depending on the gender variable (male, female).*

### **2.4. Research hypotheses**

In this research we proposed the following main study hypothesis: we believe that there is a differentiation in the manifestation of psychomotor behaviors in children who practice swimming according to the gender variable. Specifically, girls have better psychomotor skills than boys.

The secondary hypotheses derived from the main hypothesis:

*H1 - manual dexterity is significantly better among girls compared to boys;*

*H2 - body image is significantly better among girls compared to boys;*

*H3 - the laterality of the hand is significantly better among girls compared to boys;*

*H4 - body balance is significantly better among girls compared to boys;*

*H5 - body balance on water/buoyancy is significantly better among girls compared to boys;*

*H6 - spatial orientation is significantly better among girls than boys;*

*H7 - overall coordination is significantly better among girls compared to boys.*

### **2.5. Research population and sample**

The research was carried out in compliance with the ethical principles imposed by the Declaration of Helsinki of 1964. The subjects were informed about the research in which they would participate and a written consent was obtained from a parent regarding the fact that the young swimmers would be part of a study of research aimed at the area of psychomotricity.

The study population consists of children aged 8.0-9.11 years ( $M = 8.80$ ;  $SD = \pm 0.65$ ) who practice sports swimming in the Municipality of Iași, Romania, and the study sample consists of 52 subjects who practice swimming twice a week (one hour per session), at the Oxygen Pool Iași, Romania. Subjects have passed the initiation/learning stage of front crawl and backstroke styles and are in the consolidation stage.

**Table 2** *Research subjects - gender distribution*

<b>Gender</b>	<b>The research subjects</b>	<b>Percent</b>	<b>Valid Percentage</b>	<b>Cumulative percentage</b>
Male	26	50.0	50.0	50.0
Female	26	50.0	50.0	100.0
Total	52	100.0	100.0	

*The authors created the table, according to the data collected in our study and statistics used to analyze data.*

### **3. Results**

Collected data were systematized and entered into a database using IBM SPSS 20 (IBM Corp, Armonk, NY, USA). In the statistical processing of the data, descriptive analyzes were performed in order to check the distribution of the data (Kolmogorov-Smirnov/K-S and Shapiro-Wilk/S-W coefficient). The t-test for independent samples was used to check statistical differences between variables. The confidence interval taken into account was 95%.

Testing the main hypothesis and those derived from it.

To test the main hypothesis and those derived from it, we used the t-test with two independent samples, the results of which are included in Table no. 3.

**Table 3** *Descriptive statistical analysis - research variables*

Research variables	Gender	N	Mean	Std. Deviation	Std. Error Mean
1. Manual dexterity	M	26	73.38	10.21	1.61
	F	26	74.86	10.03	1.67
2. Body schema	M	26	18.65	3.59	.57
	F	26	19.81	3.48	.58
3. Hand laterality	M	26	6.10	1.30	.05
	F	26	7.14	1.35	.06
4. Body balance	M	26	11.21	2.13	.34
	F	26	12.54	1.83	.30
5. Body balance on water /buoyancy	M	26	17.79	1.74	.27
	F	26	19.24	2.24	.37
6. Spatial orientation	M	26	6.10	.304	.05
	F	26	6.87	.351	.06
7. General coordination	M	26	11.58	2.38	.38
	F	26	12.67	1.62	.27

*The authors created the table, according to the data collected in our study and statistics used to analyze data.*

In interpreting this t-test for independent samples we start from the significance value (sig) of Levene's test (F). If the value is greater than 0.05, we will use for interpretation the information on the first row of the t-Test table, if not, those on the second row (Table 4). For the research variables, the sig of the Levene test has the following values: manual dexterity = 0.79; body schema = 0.69; hand laterality = 0.30; body balance = 0.23; body balance on water/buoyancy = 0.055; spatial orientation = 0.30 and general coordination = 0.01.



**Table 4** *Testing Research Hypotheses - Independent Samples t-Test*

RESEARCH VARIABLES		Levene's Test for Equality of Variances		t-test for Equality of Means				
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
1. Manual dexterity	EVA*	.066	.799	-.63	52	.525	-1.48	2.327
	EVnA*			-.63	51.4	.525	-1.48	2.325
2. Body schema	EVA*	.153	.697	-1.41	52	.160	-1.15	.815
	EVnA*			-1.42	51.5	.160	-1.15	.813
3. Hand laterality	EVA*	1.08	.302	-2.27	52	.606	-.039	.075
	EVnA*			-2.27	50.7	.609	-.039	.076
4. Body balance	EVA*	1.45	.233	-2.91	52	.005	-1.334	.457
	EVnA*			-2.93	51.8	.004	-1.334	.453
5. Body balance on water /buoyancy	EVA*	3.79	.055	-3.16	52	.002	-1.447	.457
	EVnA*			-3.12	49.9	.003	-1.447	.463
6. Spatial orientation	EVA*	1.70	.302	-1.02	52	.607	-.770	.075
	EVnA*			-1.02	49.7	.609	-.770	.076
7. General coordination	EVA*	6.09	.016	-2.30	52	.024	-1.092	.473
	EVnA*			-2.35	49.0	.021	-1.092	.464

\*EVA = Equal variances assumed; \*EVnA = Equal variances not assumed

*The authors created the table, according to the data collected in our study and statistics used to analyze data.*

### 1. *The manual dexterity*

The manifestation of the variable manual dexterity according to the gender of the subjects shows 1.48 percentiles in favor of girls compared to boys. However, the arithmetic mean of the values obtained for this variable by male children ( $M = 73.38$ ;  $SD = \pm 10.21$ ) is not statistically significantly lower ( $t = -0.63$ ;  $df = 52$ ;  $p = 0.52$ ) compared to the mean for female children ( $M = 74.86$ ;  $SD = \pm 10.03$ ).

Therefore, we can state that the hypothesis *H1 - manual dexterity is significantly better among girls compared to boys* is disproved.

### 2. *Body schema*

From the measurements made (Goodenough Test), we find that girls have a better body schema than boys with 1.16 points. The arithmetic mean of the values obtained for this variable by male children ( $M = 18.65$ ;  $SD = \pm 3.59$ ) is not statistically significantly lower ( $t = -1.41$ ;  $df = 52$ ;  $p = 0, 16$ ) compared to the average of female children ( $M = 19.81$ ;  $SD = \pm 3.48$ ).

From the data presented above, it follows that the hypothesis *H2 - body schema is significantly better among girls compared to boys* is disproved.

### 3. *Hand laterality*

The manifestation of the variable laterality of the hand according to the gender of the subjects presents 1.04 points in favor of girls compared to boys. From the obtained data we note that the arithmetic mean of the values obtained for this variable by male children ( $M = 6.10$ ;  $SD = \pm 1.30$ ) is not statistically significantly lower ( $t = -2.27$ ;  $df = 52$ ;  $p = 0.60$ ) compared to the mean of female children ( $M = 7.14$ ;  $SD = \pm 1.35$ ).

Therefore, we can state that the hypothesis *H3 - the laterality of the hand is significantly better among girls compared to boys* is disproved.

### 4. *Body balance*

From the measurements carried out (Flamingo Test), we find that girls have better body balance compared to boys by 1.33 seconds. The arithmetic mean of the values obtained for this variable by male children ( $M = 11.21$ ;  $SD = \pm 2.13$ ) is statistically significantly lower ( $t = -2.91$ ;  $df = 52$ ;  $p = 0.005$ ) compared with the mean of female children ( $M = 12.54$ ;  $SD = \pm 1.83$ ).

From the data presented above it follows that the hypothesis *H4 - body balance is significantly better among girls compared to boys* is confirmed.

### 5. *Body balance on water/buoyancy*

The manifestation of the variable body balance on water/buoyancy according to the gender of the subjects shows 1.45 seconds in favor of girls compared to boys. From the data obtained, we note that the arithmetic mean of the values obtained for this variable by male children ( $M = 17.79$ ;  $SD = \pm 1.74$ ) is statistically significantly lower ( $t = -3.16$ ;  $df = 52$ ;  $p = 0.002$ ) compared to the mean of female children ( $M = 19.24$ ;  $SD = \pm 2.24$ ).

Therefore, we can state that hypothesis *H5 - body balance on water/buoyancy is significantly better among girls compared to boys* is confirmed.

### 6. *The spatial orientation*

From the measurements carried out (Matorin Test), we find that girls have a better spatial orientation compared to boys with 0.77 points. The arithmetic mean of the values obtained for this variable by male children ( $M = 6.10$ ;  $SD = \pm 0.30$ ) is not statistically significantly lower ( $t = -1.02$ ;  $df = 52$ ;  $p = 0, 60$ ) compared to the mean of female children ( $M = 6.87$ ;  $SD = \pm 0.35$ ).

From the data presented above, it follows that the hypothesis *H6 - spatial orientation is significantly better among girls compared to boys* is disproved.

### 7. *The general coordination*

The manifestation of the general coordination variable according to the gender of the subjects presents 1.09 points in favor of girls compared to boys. From the obtained data, we note that the arithmetic mean of the values obtained for this variable by male children ( $M = 11.58$ ;  $SD = \pm 2.38$ )

is statistically significantly lower ( $t = -2.35$ ;  $df = 52$ ;  $p = 0.02$ ) compared to the mean of female children ( $M = 12.67$ ;  $SD = \pm 1.62$ ).

Therefore, we can state that the hypothesis *H7 - general coordination is significantly better among girls compared to boys* is confirmed.

**Table 5** Results from testing the research hypotheses

Research hypotheses derived from the main hypothesis	T test	Result
H1 Manual dexterity is significantly better among girls compared to boys	$t = -0.63$ $p = 0.52$	disproved
H2 Body schema is significantly better among girls compared to boys	$t = -1.41$ $p = 0.16$	disproved
H3 Hand laterality is significantly better among girls compared to boys	$t = -2.27$ $p = 0.60$	disproved
H4 Body balance is significantly better among girls compared to boys	$t = -2.91$ $p = 0.005$	confirmed
H5 Body balance on water/buoyancy is significantly better among girls compared to boys	$t = -3.16$ $p = 0,002$	confirmed
H6 Spatial orientation is significantly better among girls compared to boys	$t = -1.02$ $p = 0.60$	disproved
H7 General coordination is significantly better among girls compared to boys	$t = 2.35$ $p = 0.02$	confirmed

*The authors created the table, according to the data collected in our study and statistics used to analyze data.*

From the data presented in table 5, it follows that the main hypothesis of the study - we believe that there is a differentiation in the manifestation of psychomotor behaviors in children who practice sports swimming according to the gender variable - is partially confirmed. More precisely, there are three secondary hypotheses confirmed and four disproved.

#### 4. Discussion

In this study, we aimed to highlight gender differences in the manifestation of psychomotor behaviors in 8–9-year-old children who practice sports swimming.

From the quantitative data analyzed in this study, it appears that girls who practice swimming have more developed psychomotor behaviors compared to boys.

At the level of the manual dexterity variable, the difference between the two groups is not statistically significant. According to studies (Binet & Vaschide, 1897; Capol & Walther, 1953; Fauche, 1994; Radu & Ulici, 2002), values of manual dexterity between 70 and 80 centiles represent good manual dexterity, which also happens in our sample (boys = 73.38 percentiles, and girls = 74.86 percentiles).

Junaid & Fellowes (2006) observed that in children between 6 and 9 years of age, boys develop ball skills earlier than girls and that girls acquire manual dexterity before boys.

In agreement with other studies (Rosa, 2006; Gherghuț, 2013; Rosa & Boccato, 2014), the values obtained by the research subjects (boys = 18.65 points; girls = 19.81 points) on the Goodenough Test are in the good category. Hence, it follows that psychomotor skill - body schema - is well represented among children who practice swimming.

If we invoke the gender variable as an independent variable, we find that girls have a better body image than boys by 1.16 points, but not statistically significant. In the study carried out by Şunei et al. (2022) measured body shape and found that there were statistically significant differences between girls and boys between the ages of 5 and 8 years. Also, characteristics regarding specific body dimensions (eg, tall, short, thin, fat, etc.) are more evident among girls. Thus, girls seem to have more knowledge about body dimensions or a greater ability to judge their body in terms of size and shape compared to boys (León et al., 2021).

Regarding the laterality of the hand, girls have a 1.04-point better manifestation compared to boys, but from a statistical point of view it is a non-significant difference. In the literature, no significant differences in performance of laterality (right-handed versus left-handed) were found according to the gender variable (Corballis, 2019; Bondi et al., 2020). The gender variable does not influence the manifestation of laterality.

The elements that define laterality are individual and complex and appear during the psycho-biological development process of each individual (Michel et al., 2013). There are studies that show that laterality manifests itself from prenatal life (Parma et al., 2017). Sensory and motor demands lead people to develop a motor asymmetry based on a lateral dominance that, once established, remains consistent throughout life (Gooderham & Bryden, 2014; Parma et al., 2017).

Related to the manifestation of static balance according to gender, Schedler et al. (2019) concluded (based on a meta-analysis of 43 studies with subjects between 6 and 18 years of age) that girls perform better than boys in demonstrating static balance, and boys perform slightly better than girls in demonstrating dynamic balance and pro-active balancing. And in our study, we found that girls have a level of body balance better than boys by 1.33 seconds, a difference that is statistically significant.

The age period between six and eight years is considered a transitional phase in the development of postural control. In this stage, balance performance increases suddenly, an aspect that is due to a better sensory and motor manifestation, as well as changes in postural control strategies (Barela et al., 2003; Bair et al., 2007).

The manifestation of the variable body balance on water (buoyancy) in children aged 8.0-9.11 years is at a good level with a statistically significant advantage in favor of girls (1.45 seconds better). McLean & Hinrichs (2008) showed, based on a study where they identified the distance (d) between the center of gravity (CG) and the center of buoyancy (CF) in male and female swimmers aged 18-19 years, that girls have much smaller d-spacing compared to boys and, by implication, better buoyancy. Depending on the locations of the CG and the CF, the body can be stable, neutral, or unstable in the aquatic environment (Yanai & Wilson, 2008).

All children use spatial concepts in various areas of their lives, as they are useful for reading, writing, running, playing, etc. However, this capacity is often not adequately developed. There are cases when the child perceives space in relation to his body, it is clear to him that he is surrounded by peers and objects, but it is difficult for him to differentiate them, to classify them in order to identify a given distance (Blakemore, 2008). In our research, there are no statistically significant differences between female and male subjects in the manifestation of the spatial orientation variable.

From the analysis of the quantitative data, it appears that the general coordination variable has a significantly better statistical level among female persons compared to male persons. Among children aged 8.0-9.11 years who practice swimming, girls have 1.09 points better overall coordination compared to boys. The literature, Battaglia et al. (2021) shows the same kind of results - significant differences between girls and boys in favor of girls.

Although the conduct of the study brings some positive elements to the knowledge, the relatively small group of subjects can be considered a limitation of the study. A more extensive statistical analysis using other

instruments, on more psychomotor components and on a larger number of subjects may constitute future directions of analysis.

## 5. Conclusions

The psychomotor behaviors useful in practicing swimming are manifested differently depending on the gender variable, among children aged between 8.0-9.11 years. In all psychomotor skills measured and evaluated in this research (body schema, manual dexterity, hand laterality, body balance, body balance on water, spatial orientation, general coordination), the subgroup of girls obtained better results compared to the subgroup of boys.

We specify the fact that for four variables invoked from the area of psychomotricity (manual dexterity, body diagram, laterality of the hand and spatial orientation), the differences between the arithmetic means of the two subgroups were not significant from a statistical point of view (they had the significance threshold  $-p-$ , accepted by the academic community, greater than 0.05).

In the other three variables (body balance, body balance on water and general coordination) the differences between the arithmetic means of the two research subgroups (girls and boys) are statistically significant, they have a significance threshold of less than 0.05.

From this we can draw a conclusion that could be used as a hypothesis in a future study that girls can swim (or learn to swim) better than boys.

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