Can You Swim in Waves? Children's Swimming, Floating, and Entry Skills in Calm and Simulated Unsteady Water Conditions

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Little is known about the transfer of swimming skills from indoor, flat, calm conditions to outdoor, wavy, unsteady conditions. The aim of the current study was to examine the differences in swimming, floating, and entry skills in children between calm and simulated open water conditions. Sixty-six children, 11 years of age, were tested on two occasions, once in calm water and once in simulated open water conditions. Testing consisted of a 200 m time trial, a 3 min back floating test, a diving entry, and a rolling entry. The results show an 8% decrement in performance on the 200 m swim between calm and unsteady conditions for those who completed the 200 m under both conditions. When weaker swimmers, who only completed 50 m of the 200 m test distance were tested, the performance decrement rose to 14%. The diving entry, the rolling entry, and the floating test had decrements of 16%, 21%, and 24%, respectively. We concluded that 11-year-olds should not be expected to reproduce swimming skills they have performed in calm water with the same proficiency in unsteady conditions during an emergency.

Keywords: swimming skills, floating skills, diving skills, children, simulated open water

Most swimming instructions at the beginning level are likely conducted in swimming pool settings or if outdoors in calm water. Beginners appear to benefit from swimming in calm water conditions during the first steps of acquiring swimming proficiency. In some countries, outdoor teaching in a lake or the sea is possible, but most swimming instructional settings are likely in pools. Although some surf lifesaving schools (e.g., in Australia or New Zealand) teach water competency in the surf and under unsteady conditions, most beginners stop their swimming education when the "calm water course" is over. Since most drowning incidents occur in open water (e.g., Thow, Naemi, & Sanders, 2012), it would appear sensible

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for swimmers to master a range of aquatic skills in open water conditions including choppy water surface, waves, spray, cold, and poor water visibility as well as under adverse weather conditions of wind, rain, and darkness. One crucial issue in drowning prevention is the lack of evidence-based research that documents the degree to which aquatic skills performed under calm water settings transfer to choppy or wavy open water settings.

Fatal and nonfatal drowning incidents happen in many arenas. One study documented that in the tropical islands of Hawaii, 41% of drowning accidents happened in pool settings while only 39% in a surf or bay area setting (Thow et al., 2012). These statistics illustrate that both calm and unsteady water conditions are arenas for incidents. Drowning accident statistics in Norway show only 7% of the cases were in the category *bathing,* which include pool and beach activities. The rest of the fatal drowning accidents during the period of 1998–2010 happened in outdoor settings (e.g., sea, lake, or river). This meant that over 93% of drowning accidents happened in open water (Norwegian People's Aid, 2012). Unfortunately, there are a limited number of studies that have investigated how well persons may perform typical swimming skills or swimming performance in such conditions.

One study measured the differences in lifeguard performance when swimming in a pool versus swimming in the sea in both calm and surf conditions (Tipton, Reilly, Rees, Spray, & Golden, 2008)., These investigators found significantly slower swimming speed in surf compared with calm sea ($p < .01$) and in calm sea compared with pool swimming ($p < .01$). They found a reduction in swimming performance (i.e., slower swimming speed) from a pool setting to calm sea swimming of 10%–12% and from calm sea to surf sea swimming of 30%–57%. Furthermore, in this study, the authors attributed an 18% performance improvement for swimming in the surf to practice of surf swimming skills (i.e., experience in swimming and moving in the surf) not attributed to pool swimming skill. The greatest loss in efficiency from pool to open water was among those swimmers who were least experienced. These statistics based on adult lifeguards probably cannot be directly transferred to children.

We found no evidence of previous research that had investigated swimming performance differences between calm and unsteady water conditions for other basic water competency skills such as floating, diving, underwater swimming, and swimming for technique. Yet these skills are important aspects of the concept of water competence (Langendorfer & Bruya, 1995; Stallman et al., 2011), especially related to survival skills.

After children have learned basic swimming skills under calm, safe, and secure conditions, their leisure activities can often expand to include outdoor aquatic activities. With a higher risk of drowning in many open water recreational settings other than in swimming pools (Norwegian People's Aid, 2012), it is important that children can handle the outdoor environmental challenges with confidence. Thus, we were curious: How well do typical "learn to swim" skills transfer from a pool setting to outdoor conditions?

Ducharme and Lounsbury (2007) claimed that performance in cold water swimming (10°C) results in one third of the distance covered compared with the distance when swimming in warmer water (24°C). The difference in distances relates to adults only and deals with the differences in performance related to cold water stress. There seems to be little or no evidence on transfer of performance related to children or to swimming in waves. Tipton et al. (2008) found that experience

(e.g., skill level) correlated strongly with loss of efficiency in the transfer from pool to open water and then to surf where the weakest lifeguards had the greatest loss of efficiency.

Learn to swim lessons are compulsory in the Norwegian School system. Because 93% of fatal drownings occur in open water in Norway, we expect that government officials, school owners, teachers, and parents need to know whether the teaching done indoors prepares Norwegian students to face the risk of real outdoor conditions and whether indoor instruction has significant protective value when the children are in open water conditions.

The purposes of this study were to explore whether differences occurred in swimming skill and performance among 11-year-old school children between calm and unsteady water conditions and to investigate whether initial performance level influences the degree of transfer of performance from calm to unsteady conditions.

Method

Participants

This study is part of a larger project called "Can You Swim in Waves?" where several investigations were undertaken to reveal how well children transfer their skills from calm water conditions to unsteady or wavy water conditions and how perceived and real skills are performed in simulated unsteady, wavy, or choppy water conditions. It is part of a series of studies in the "Can You Swim" project (Moran et al. 2012). A paired, randomized, repeated measures (test-retest) experimental design was chosen where the participants served as their own controls. Of 101 children from the larger project, 66 took part in this experiment. Written parental consent was obtained and the local ethics committee approved the project and procedures. The participants (all 11-year-old children) consisted of 39 (59%) girls and 27 (41%) boys. Before the project, they had participated in a total of 45 swimming lessons, each 40 min in duration, dispersed over 3 years (grades 2–4) as part of the required academic curriculum. The age of 11 was chosen because students are obliged to be "able to swim" by the Norwegian school system at this age.

Protocol

Investigators administered a 200 m time trial, a 3 min floating test, a diving entry test, and a rolling entry test on two occasions, once in an indoor 25 m pool with a water temperature of 27°C in a calm water setting and once in a similar indoor pool under wavy conditions. The pool was equipped with a wave-making device called a wave ball (WoW Company, Nanine, Belgium). The ball that floats on the surface has an internal mechanism of moving weights, constructed such that internal movement results in vertical movement of the ball on the water surface (Figure 1). Waves are dispersed from the ball in a circular pattern, and reflecting panels along the pool edges make the waves refract back into the pool. The result is an "unsteady" or wavy water surface, behaving chaotically, with wave amplitudes from top to bottom of 30–40 cm. The calm water tests were done in a similar pool without the wave-making device. All skills tests were done in a randomized and balanced order such that half the swimmers were tested in calm water first and the other half were tested in unsteady conditions first.

Figure 1 — Setup of wave-making ball.

200 m time trial.   During testing, the swimmers were asked to swim 200 m breaststroke as fast as they could, but not with maximal speed at the start to minimize the effect of "a too fast start and inability to finish" for those swimmers who were less accustomed to this distance. They were instructed to prioritize finishing the distance while swimming as fast as they could for the entire 200 m. All swims were timed using a video camera (Sony HDR CX730E, Sony Inc., Japan) with a time-code overlaid on the recording. In addition to the 200 m finish time, lap times for each 50 m lap were recorded, as well as the time required to complete each turn at 50 m, 100 m, and 150 m, recorded as the time between the hand-touch and the toe-off from the turning wall.

Diving and rolling entries.   The swimmers dove from the pool edge which was 30 cm above the water level into the water from a standing position and glided underwater and back to the surface. The dive form was scored as described in Table 1. All scores were from 1 to 5, adapted from the Aquatic Readiness Assessment (Langendorfer & Bruya, 1995).

The rolling entry was performed using the following instructions: Swimmer must roll headfirst, chin tucked in, one hand on the back of the head, one arm around the lower legs in a tucked position, thereafter surfacing, and reorienting to a back floating position. A small forward movement away from the pool edge is necessary. Swimmers must demonstrate little hesitation, easy rotation of body under water, orientation skills to surface with head first, and ending in a safe-for-breathing back float position. Like the diving performance, the rolling entry performance was scored according to Table 1.

Inter- and Intra-rater Agreement

Before the raters scored the rolling, diving, and floating data in this study, they were trained in a pilot study. The rater objectivity of the testing and evaluation methods was approached by analyzing a random sample of the same individuals on two occasions (initial test—retest). This was done using the same observer (intra-rater agreement) and also across two different observers (inter-rater agreement).

Table 1   Floating, Diving, and Rolling Test Scores

Score	Floating	Diving	Rolling
1	Cannot float on back, less than 10 s, sinking, hesitating, or almost vertical floating position, excessive movements with legs and arms, mouth over water sporadically	No dive–hesitated jump (not completed)	No roll–hesitated jump (not completed)
2	Movements with arms and legs, 60° angle, mouth over water almost all of the time	Hesitated dive, splash, unclean entry, disoriented underwater (form), belly flop	Hesitated roll or poor dive, slow orientation, no back position, does not rotate completely (disoriented; form)
3	Mouth over water continuously, moves legs or arms, 45° body angle	Dives without hesitation, some splash (satisfactory form)	Rolls in easily, orients more easily, long time to reach back position (satisfactory form)
4	Nearly horizontal, small movements with legs	Little splash, easy exit, and nice trajectory (form)	Easy roll, quick orientation, some hesitation to back (form)
5	Floats easily with no movement of arms or legs, horizontal	No splash, clean entry, glides with exit (excellent form)	Effective and complete roll, complete orientation, quick to reach back position (excellent form)

Statistical Analysis

The data were treated statistically using paired repeated measures *t* tests using the SPSS 19 statistical package (SPSS, IBM Corp., Armonk, NY). Additional calculations were conducted to find the total turn time—the sum of the turn times at 50 m, 100 m, and 150 m. To calculate the deviation in velocity from the velocity of the first 50 m, the differences between the time of the 50 m lap and the subsequent three 50 m laps were summed (total drop = [(t50-t100) + (t50-t150) + (t50-t200)], where t50 is the lap time from 0–50 m, t100 is the lap time from 50–100 m). This variable, total drop time, is meant to reflect any unevenness in velocity among the four 50 m laps of the time trial. The Type I error rate for each *t* test was controlled at $\alpha = .05$.

Results

Of the 66 participants, 53 finished the entire 200 m distance under calm conditions (80%) and 39 (59%) finished in the unsteady condition. The mean ± *SD* finish time was 455 ± 75seconds (s) for calm water versus 492 ± 90 s for the unsteady conditions, respectively. The mean difference of +38 s additional time required for swimming 200 m in the wavy condition represented 8% longer time than in the calm water conditions. This difference was statistically significant ($p < .001$),

with a 95% confidence interval for the difference of 25–49 s. Individual paired differences are shown in Figure 2.

The finish time for the first 50 m lap which included those who did not finish the 200 m distance was 115 ± 26 s for the calm water versus 123 ± 28 s for the unsteady condition. The mean difference of +16 s represents 14% increase over calm water time. This difference was statistically significant ($p < .001$) with a 95% confidence interval for the difference of 11–22 s. Apparently the unsteady condition produced an immediate and significant impact, slowing swimmers during the initial 50 m of the swim. The total drop (or slowing time) between the first and fourth 50 m lap was 38 ± 34 s versus 24 ± 33 s for the calm water versus unsteady condition, respectively, which was not statistically significant (n.s.), showing that in general that those who completed the entire 200 m did not lose significantly more speed during the final 50 m compared with the first lap under the unsteady condition. We noted the large degree of individual variability in how the unsteady condition impacted different swimmers. Furthermore, the total turn time which was the sum of how long the subjects used to turn and take short breaks at the wall between laps was not different between the two conditions. It totalled 14 ± 26 s for the calm water and 16 ± 23 s for the wavy condition. A calculation of the correlation between the performance level in the calm condition and the relative difference between calm and unsteady conditions showed a low and statistically nonsignificant correlation, meaning that the initial performance level did not associate strongly with the resulting slowing in swim time under the unsteady condition (see Figure 3).

The results of the rolling entry test showed an average of 21% lower scores when rolling into waves compared with the calm water test ($p < .05$, paired t test),
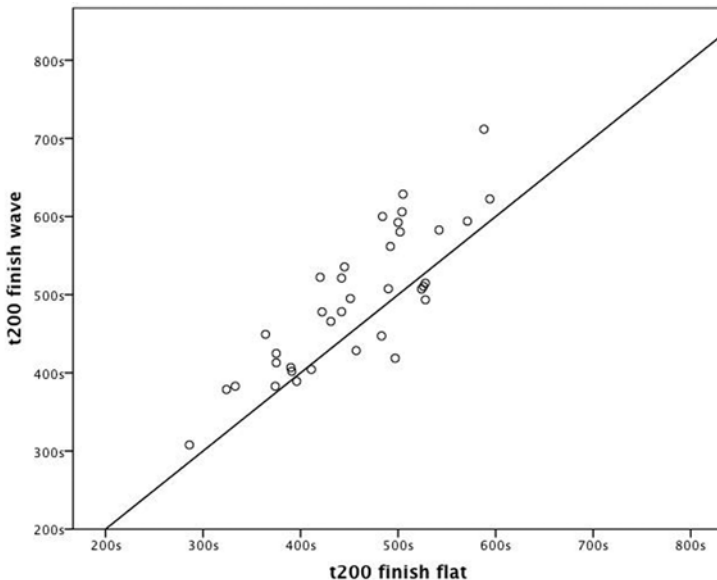
Figure 2 — Total time for flat (x axis) and wave (y axis) conditions (numbers in seconds). Solid line is y = x and represents equal time of the two conditions.
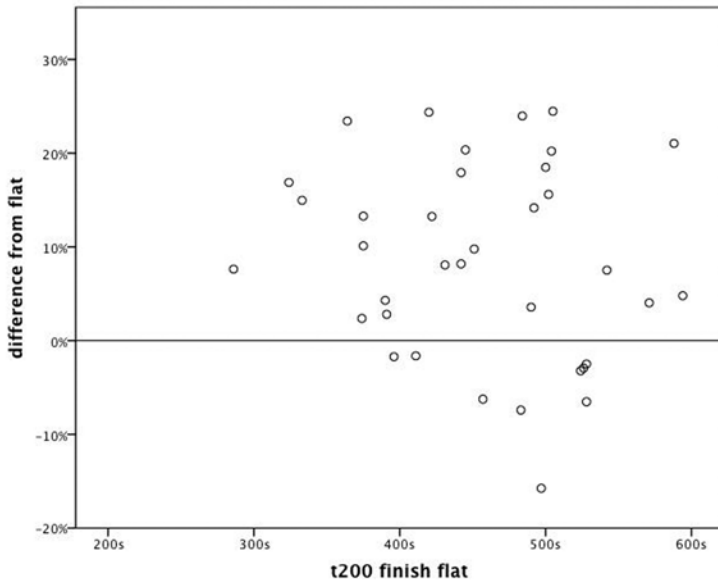
Figure 3 — Finish time for flat-water condition (x axis) and percent difference between flat and wave conditions (y axis).

with an average score of 3.31 ± 1.32 versus 2.88 ± 1.62 for calm compared with unsteady conditions respectively. The average individual difference in rolling score between calm and unsteady conditions was 0.61 ± 1.48 (95% C.I = 0.27–0.95).

For the diving test the results showed a similar pattern to the head-first rolling entry. The diving score was on average 16% lower in waves than in the calm water test ($p < .05$, paired t test), with an average score of 3.13 ± 1.23 versus 2.52 ± 1.43 for calm water compared with unsteady conditions, respectively. The average individual difference in diving scores between calm and unsteady conditions was 0.49 ± 1.5 (95% C.I = 0.24–0.75).

The floating score was significantly lower with 3.1 ± 1.3 for the unsteady condition compared with 3.7 ± 1.2 for the calm water condition ($p < .01$). The average difference in scores was 0.9 ± 1.40, which equaled -24% of the calm water score with a 95% confidence interval of 0.59–1.21. Similarly, the floating time was significantly shorter when floating in waves compared with calm water, with 57.5 ± 50.7 versus 145.3 ± 57.1 s, respectively ($p < .01$). The average difference was 97.3 ± 62.3 s (66%, 95% C.I = 83.7–110.8).

The results of the examination of the measuring methods showed very good reliability. There were no statistical differences between initial test and retest for any of the variables (i.e., floating score, diving score, rolling entry score, 200 m times, and flotation times). Intra- and inter-rater agreements as measured with intraclass correlations (ICC) were all in the range of 1.00–0.85. Table 2 shows average differences and confidence intervals for the intra-observer objectivity tests, and Table 3 shows the inter-observer reliability.

Table 2   Intra-Observer Reliability. The Mean, Standard Deviation (*SD*), Number of Samples (n), 95% Confidence Intervals (95% CI) and Intra Class Correlation (ICC) of the Difference Between Test and Retest for the Same Observer (ICC=Absolute Agreement)

	Mean	*SD*	n	95% CI	ICC
Diving score (0–5)	0.12 (4%)	0.48	34	-0.05–0.28	0.94
Rolling score (0–5)	0.05 (1%)	0.51	33	-0.13–0.22	0.93
Floating score (0–5)	0.15 (4%)	0.58	20	-0.12–0.42	0.93
Floating time (0–180 s)	2.50 (2%)	5.50	20	-0.04–5.10	1.00
200 m and lap times (s)	0.03 (0.5%)	0.85	140	-0.11–0.17	1.00

Table 3   Inter-Observer Reliability. The Mean, Standard Deviation (*SD*), Number of Samples (n), 95% Confidence Intervals (95% CI) and Intra Class Correlations (ICC) of the Difference Between Test and Retest for Two Different Observers (ICC=Absolute Agreement Average Measures with 2 Observers)

	Mean	*SD*	n	95% CI	ICC
Diving score (0–5)	0.13 (4%)	0.83	8	-0.45–0.58	0.92
Floating score (0–5)	0.06 (2%)	1.11	18	-0.50–0.61	0.85
Floating time (0–180 s)	5.00 (11%)	12.00	18	-1–11	0.99
200 m and lap times (s)	0.06 (0%)	0.66	40	-0.14–0.27	1.00

Discussion

Test Reliability and Rater Objectivity

Each test showed a high degree of consistency based on the high intra- and inter-rater agreements between the original test and its subsequent reanalysis. These compare favorably with Erbaugh (1978) who found intraclass correlation coefficients between 0.99–0.84 for test-retests when assessing swimming skills in children 2–6 years of age and more recently with older children and adolescents (Sršen et al., 2012). Langendorfer and Bruya (1995) suggested calculating percent (proportion) of exact agreement (P) which ought to exceed 80% instead of calculating correlations when doing qualitative assessment. We concluded that the ordinal scale form scores for floating, diving and rolling entry skills, as well as the ratio scale swimming and floating times can serve as reliable methods for investigating aquatic skills in children. To our knowledge this is the first time that the reliability of floating, rolling entry, or diving tests have been reported in the published literature.

Test Validity

We established that the content validity of the floating, diving, and rolling test was high for each test separately based upon the accumulated aquatic expertise provided by the study investigators who all have aquatic expertise and international reputations. These tests combined provide a valid composite test reflecting self-rescue skills, based on a content analysis of aquatic skills believed important in drowning prevention (Stallman, Junge, & Blixt, 2008). Although in this experiment the ecological validity is less important when comparing the intervention (unsteady condition) with the control situation (both conducted in the same indoor pool setting), strong ecological validity is important if these tests are to be used to make judgments about the transfer of swimming skills from indoor or pool conditions to real outdoor and open water conditions. Future research on establishing the degree of ecological validity of the can you swim tests must take this into consideration. Because test validity is highly contextual, each future study must be able to demonstrate satisfactory validity in its own right.

Swim Time Performance Decrements and Transfer Across Conditions

The main finding of this study was that an 8% increase in 200 m swimming performance time was observed when relatively small waves (approximately 30–40 cm wave amplitude) were introduced in the pool during the unsteady condition. To our knowledge, this is the first time that a simulated outdoor aquatic condition has been investigated in which children were the participants. While the 200 m swim time increase from calm water to simulated unsteady water appears to be relatively small (-8%), it represents an important performance decrement for several reasons. First, the performance difference of 8% represents the results for 11-year-olds with a 4-year history of formal swimming lessons. Second, one fifth (20%) of these experienced children did not complete the 200 m in calm conditions, and even more (41%) did not finish in the unsteady condition.

The performance differences must take into account that the group who completed 200 m under both conditions presumably consisted of more skilled performers. Further investigations of the swimmers who did not complete one or both 200 m swims ought to be undertaken to enlighten us on the performance transfer of less skilled swimmers as well as perhaps why some individuals do not acquire the same skill level under the required swimming curriculum. To assess differences in skill transfer across conditions the first 50 m of the 200 m was investigated, where 100% and 79% of the initial 66 subjects finished for the calm and unsteady conditions, respectively. The difference in velocity between calm and unsteady conditions increased from 8% for those completing the entire 200 m test compared with 14% for those completing the first 50 m lap which included those swimmers who were unsuccessful in completing the full distance. Including the weaker swimmers almost doubled the percentage time decrement between the calm and unsteady water conditions. We recommend further studies to investigate how well or poorly less skilled swimmers may learn to transfer skills from a calm water to unsteady water conditions.

Interestingly, we found no significant correlation between calm water performance on the rate of performance transfer from calm to unsteady conditions. Our findings with 11-year-olds contrast to the study results by Tipton et al. (2008), who found a clear effect of initial performance and training level in beach lifeguards. One reason for this discrepancy may be that the performances had large variations, and that their day to day variations in performance were a factor during testing. Another explanation may be that we employed more lifeguards on the pool deck during the wave testing condition signaling that we considered the situation to be more "serious" with a greater risk of swallowing water and encountering difficulty. As a result, it is possible that the swimmers perceived the greater risk involved and gave a greater effort (e.g., "swam for their lives"). In the Tipton et al. study (2008), the outdoor conditions involved actual surf waves, which were different by being larger, but more regular than our simulated (and smaller) waves which were chaotic and nonrhythmic. There is a possibility that there is an effect of initial performance on the performance transfer rates between young adults and children as well as between different specific environmental conditions.

Floating Time Decrements and Transfer Across Conditions

Time for floating in calm water averaged 145 s or approximately 2.5 min. This is comparable, or even better, than adult sport science students in the "Can You Swim Study" where 33% could stay afloat for only 2 min. Additionally, 20% could stay afloat for only 2–6 min (Moran et al., 2012). The floating performance was found to be shorter in the unsteady condition compared with the calm water condition with respect to both performance rating score and floating time. The 24% decrement in performance rating was similar in magnitude to the rolling entry and diving score decrements, but the 66% shorter wave-floating time is a substantially larger decrement in performance.

Looking at the rating score descriptions in Table 1, introducing waves meant that the floating performances on average went from using either arms or leg movements to using both arms and leg movements combined to remain in position. Furthermore the estimated floating angle increased from 45°–60° from the horizontal. The less favorable body position under the unsteady condition resulted from adjustments (e.g., holding the arms more adducted or legs kicking more) and may have lowered the body's center of gravity causing a more vertical floating position as the swimmer attempted to keep the face above water to facilitate breath control. It should be pointed out that the observation of the trunk floating angle was by visual inspection only and did not use more precise measurements. Therefore the unsteady and wavy water surface could have biased the observations without a lower body position actually occurring. Nevertheless the decrement in floating time between the two conditions was substantial. Because staying afloat is a major contributor to survival in an aquatic emergency, it suggested that learning and mastering floating skills under unsteady, wavy water conditions may comprise an important aquatic skill competency for the novice swimmer.

Visual inspection of the floating videos showed that there were several reasons why the subjects terminated their floating tests before the end time of 3 min. Under the unsteady conditions, splashes of water in the face and waves breaking over the head were some of the more common occurrences that were not present under the

calm water conditions. Those who struggled with the floating skills in both conditions seemed to have "legs sink," "head under," "arms at the side" (which lead to legs sinking) as observed form descriptions that might have lead to stopping the test. Those who floated for the longest periods seemed to hold their arms above their heads and kept the back of their heads relatively low in the water, lying more comfortably and not struggling to "get the face out" of the water. We observed from the videos that the swimmers with shorter floating times and lower floating scores tended to lift their heads higher out of the water which was related to decreased buoyancy and greater vertical body position.

Entry Decrements and Transfer Across Conditions

We observed that the diving and rolling entry rating scores were lower under the unsteady conditions compared with calm water, with reductions of 16% and 21% for the diving entry and rolling entry, respectively. The investigators had not expected the extent of these decrements compared with those of the floating and swimming performance decrements. Both the floating and swimming performances happen in the water where the waves directly affect the swimmer, whereas the waves should not have had such a direct effect on the rolling and diving entries from the pool deck into the water, at least during the take-off and flight phases of these performances. We speculate that the lower scores in rolling and diving are more related to the mental aspect of the children's performance, where anxiety and fear of the upcoming event may have played a greater role. From research with cold water shock response, Barwood and colleagues (2013) found that anxiety substantially reduced the "time to stay" in the cold water for adults (Barwood et al., 2013). This same research group also found that psychological intervention training increased the average breath holding time during cold water immersion by 80% (from 24–44 s) for adults (Barwood, Dalzell, Datta, Thelwell, & Tipton, 2006), and habituation to cold water increased breath holding time by 14 s or 73% (Barwood, Datta, Thelwell, & Tipton, 2007).

The reader should keep in mind that, although entry skills are not direct swimming (or survival) skills, they are important self-rescue skills and are an integral part of what should comprise general water competence. To get into the water comfortably and to reorient the body in a good breathing position after the entry is important to avoid an increased risk of drowning. Some argue (Stallman et al., 2008) that diving and rolling entries not only require more confidence but also may to some extent simulate an involuntary fall into deep water.

Enhancing Transfer Across Conditions

To cope with adverse outdoor aquatic conditions more safely, it might be advantageous for learners to achieve a higher and more reliable standard of aquatic skill acquisition than is normally necessary to demonstrate competence in calm water conditions. When learning to swim in indoor and calm water pools, we suggest it is both possible and important to include exercises that simulate unsteady water conditions and to develop water competence skills to a higher level of competence and mastery. For example, instructors can introduce learning activities and games which (a) make waves using either a wave-making machine or kick boards or

other swimmers splashing while having swimmers swim, float, and dive in them, or (b) make a group-whirlpool by running in a circle, then floating in the current, or (c) use other splashing exercises while learning a variety of aquatic skills such as floating, swimming, and entry. Since the transfer of aquatic skill performances from calm water to unsteady conditions lead to obvious and significant performance decrements, a degree of "over learning" is assumed to be both beneficial and necessary in calm water teaching. We propose that programs and instructors ought to add targeted experiences with wavy or other unsteady conditions to the learning of fundamental aquatic skills such as entry, floating, and swimming skills.

Conclusions

To swim in unsteady, wavy, or choppy water is quite a different task than swimming under calm water conditions. The empirical evidence presented in our study shows obvious performance decrements ranging from 8% for 11-year-old children who swam 200 m to a 66% shorter floating time in small (i.e., 30–40 cm) chaotic waves generated mechanically in a pool. The qualitatively-rated performance of floating and entry skills also were less advanced in unsteady compared with calm conditions. For actual outdoor situations including those involving cold water, the investigators expect a much larger effect may occur. Based upon the observed results in our study, we recommend that a thorough and large enough training dose of open water simulation games/exercises should be included in all learn-to-swim programs to prepare candidates for uncertain and more demanding outdoor water conditions. Learn-to-swim programs conducted indoors or outdoors in pools ought to include some form of instruction and/or experience which can be simulated easily in ordinary pools that focuses on performing skills in unsteady water. Where possible, learning experiences at developmentally appropriate levels under actual open water conditions should be integrated into such learn-to-swim programs to complement the simulated unsteady water pool activities. Finally, it seems logical to focus on introducing and acquiring knowledge and attitudes necessary for survival in open water conditions.

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