Differences between young children's actual, self-perceived and parent-perceived aquatic skills

D'Hondt, E., Bulens, L., Barnett, L., Howells, K., Saakslahti, A., Costa, A.M., Jidovtseff, B., Mertens, L. and De Martelaer, K.

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Abstract

As drowning is a leading cause of unintentional injury/death in children worldwide, perceptions of their actual aquatic skills are of critical importance. Children's self-perceptions may influence the risks they take, and parental perceptions may influence the degree of supervision deemed to be necessary for children in and around water. Accordingly, we examined the differences between young children's actual, self-perceived and parent-perceived aquatic skills. Using a three-way repeated measures ANCOVA, we analyzed data from 134 child-parent dyads (56.0% boys; *M* age = 7.1, *SD* = 1.1 years; and 71.6% mothers). We measured self and parental perceptions of the child's aquatic skills with the 'Pictorial Scale of Perceived Water Competence' (PSPWC), and we applied the exact same 17 test items of the PSPWC to assess the child's *actual* aquatic skill level in the water. Controlling for years of swimming school experience, within-subject differences between the total scores on the 'Actual Aquatic Skills Test' (AAST) and both the child- and parent-completed PSPWC indicated both parties had a lower than actual estimate of the children's aquatic skill level. The degree of disagreement against the AAST was more pronounced in parents than in 6-7 year-old children but was similar between parents and 8-9 year-old children, with these patterns being evident regardless of the children's sex. Our study contributes to an ongoing validation of the PSPWC and represents a key advance in assessing and comparing children's actual and perceived aquatic skill competence, using perfectly aligned instruments. Future research and practice might explore children's actual aquatic skills in different contexts (e.g., open water), include perspectives of non-parent caregivers and assess perceived and actual water competence across development.

Keywords

Water safety, swimming, aquatic literacy, motor competence, perceived competence, children, self-perception, parents, proxy report, pictorial scale

Introduction

Drowning remains a leading cause of unintentional death worldwide, comprising no less than 7% of all injury-related deaths (World Health Organization [WHO], 2014, 2020). Nearly 60% of fatal drownings occur among individuals aged less than 30 years, with children under 14 years considered as one of the largest drowning risk groups (WHO, 2014, 2020). Since playing in or around water remains a popular leisure activity among this young(er) population (Hulteen et al., 2017), it is vital for children to develop an adequate level of water competence. From an early age onwards, all children should be provided with opportunities to learn and master aquatic skills, with a focus on survival (Brenner et al., 2006; Weiss & American Academy of Pediatrics Committee on Injury, Violence, and Poison Prevention, 2010). Additionally, it is important to promote children's safe attitude and knowledge of possible dangers in, on and around the water. Becoming water competent (i.e., having the necessary physical/motor, cognitive and affective abilities) benefits children's water safety in pursuance of drowning prevention (Langendorfer & Bruya, 1995; Stallman et al., 2017; Szpilman et al., 2020; Taylor et al., 2020). With these motives in mind, the present study focused primarily on children's physical/motor skill competence in an aquatic environment, using both objective and subjective methods to provide direct and indirect assessments (Bardid et al., 2019) of their actual and perceived aquatic skill levels, respectively.

Perceived motor skills represent an individual's self-perception of their actual motor skills (Logan et al., 2015). In general, one's perceived skill level is based on the interplay between four psychological constructs: (a) past experiences, (b) difficulty or challenge associated with the outcome, (c) reinforcement and personal interactions with significant others, and (d) intrinsic motivation (Harter, 1996). Parental and other adult feedback mainly determines younger children's self-perception, whereas older children

and adolescents primarily rely on peer comparisons (Bois et al., 2005; Toftegaard-Stoeckel et al., 2010). In relation to their cognitive development, children's ability to self-perceive improves with increasing age (Harter, 1982, 1999). Coppens (1986) reported that comprehension about safety and prevention was linked to the highest levels of logic and more complex cognitive processes, perhaps helping to explain a higher number of accidents reported for younger children. Recent research regarding this moderating effect of age on the association between levels of actual and perceived motor competence has mainly focused on dry land skill performance (Frost & McKelvie, 2004; Potard et al., 2016; De Meester et al., 2020). In addition, previous research has suggested that motor competence is a key determinant of physical activity, particularly since perceived competence has been found to be associated with intrinsic motivation toward physical activity (Losier & Vallerand, 1994; De Meester et al., 2016). Children, who perceive themselves as highly skilled or motor competent, have been found to be more physically active than peers with low self-perceived motor skills (Robinson et al., 2015; Stodden et al., 2008). Sex also has a significant impact on children's perceived motor competence, with boys usually showing higher levels of self-perceived physical competence than girls (Barnett et al., 2015; Hall et al., 2019; Liong et al., 2015; Niemistö et al, 2019; Rudisill et al., 1993; Slykerman et al., 2016).

Yet, studies on the association between children's actual and perceived motor skill competence in an aquatic environment are scarce. Considering aquatic skills, previous research has often been limited to children's self-reported estimates of their swimming abilities, primarily with respect to what distance a child can swim (Stallman et al., 2014; Terzidis et al., 2007). Similarly, the focus in past studies of water competence has often been on adolescents and young adults' swimming abilities (Moran et al., 2012; Petrass et al., 2012; Petrass & Blitvich, 2014). Given that many

aquatic skills, such as self-propulsion in water, are essential for survival (Langendorfer, 2015) and that swimming is considered a foundational skill for lifelong physical activity engagement (Audrey et al., 2012; Hulteen et al., 2018), this topic clearly warrants more scientific investigation from an early age onwards. Costa et al. (2020) recently showed that 6-10 year-old children's perceived aquatic competence differed significantly from their actual aquatic competence in most skills identified as relevant for surviving an aquatic accident. Moreover, these authors found that younger children are more likely to overestimate their actual aquatic skill levels, potentially endangering this population. Therefore, accurate self-perceived aquatic skill competence is important as a means of fostering water safety.

In addition to the need to more closely examine the relationship between both children's actual and self-perceived aquatic skill competence, there is a critically important concomitant need to compare parental perceptions and children's actual aquatic skills (De Pasquale et al., 2020; Morrongiello et al., 2014). In studies conducted on dry land, investigators have found low to moderate agreements between children's and parents' perceptions of children's actual motor competence (Duncan et al., 2018; Kennedy et al., 2012; Lalor et al., 2016; Raudsepp & Liblik, 2002; Toftegaard-Stoeckel et al., 2010). When considering the accuracy of parental perceptions or estimates of a child's motor skills, parents are generally able to assess their children's actual motor skill competence (Liong et al., 2015; O'Neill et al., 2014). O'Neill et al. (2014), for example, demonstrated that parents of children in the highest locomotor tertile perceived their children's competence to be higher than parents of children in lower tertiles, while parents of children in the lowest object control tertile perceived their children's competence to be significantly lower than parents of children in higher tertiles. In the context of movement in water, however, the importance of an accurate

parental estimate increases because parental perceptions of their children's aquatic skills in, on and around water influence the level of supervision they deem to be necessary for children's safe engagement in various aquatic activities (Matthews et al., 2018; Morrongiello et al., 2014). Moreover, research has shown that drownings among children can be largely attributed to insufficient parental supervision (Moran, 2009; Morrongiello et al., 2014).

Despite the importance of accurate self-perception and parent-perception of a child's aquatic skills, only limited research to date has focused on the relationship, and more importantly, the degree of (dis)agreement between these perceptions and children's actual aquatic skill levels (e.g., Costa et al., 2020; De Pasquale et al., 2020). This limited research on aquatic skills is in stark contrast with the ever-increasing reports of actual and perceived motor competence on dry land (De Meester et al., 2020; Estevan & Barnett, 2018; Hulteen et al., 2020). There is an urgent need to close this literature gap, and there is an associated need for validated tools to assess children's actual and perceived aquatic skills. Accordingly, our aim in the present exploratory study was to investigate the differences between young children's actual, self-perceived and parent-perceived aquatic skills, considering their sex (boys vs. girls) and age group (6-7 year-old vs. 8-9 year-old).

Method

This exploratory study used an observational, cross-sectional design and was conducted in collaboration with six swimming schools located in Flanders and the Brussels Capital Region, Belgium. Each of these swimming schools applied or were inspired by the 'Baan 4' program (Roelandt et al., 2014; https://www.baanvier.be) and/or awarded so-called 'Fredbrevet' swimming certificates (https://frebrevet.be). The

main principle of this educational swimming program is that both fundamental and survival-related aquatic skills (e.g., floating, rotating, immersion, aquatic breathing, treading water, etc.) must be mastered before children learn specific swimming strokes. The core idea behind developing and obtaining a number of predefined aquatic competencies in the sequence of certificate levels is to stimulate a transfer of learning from practicing in an indoor swimming pool to skills and activities in more dynamic and challenging aquatic environments, as suggested by Guignard and colleagues (2020).

Participants

By means of convenience sampling, we recruited participants (i.e., 6-9 year-old children and one of their parents) from among attendees of the six swimming schools mentioned above. Recruitment was done by personally addressing children's parents in the entrance hall or cafeteria of the respective swimming pools. We excluded children who did not speak Dutch, French or English, who had any known diseases, conditions or disorders (e.g., obesity, intellectual disability, Down's syndrome, Ehlers Danlos syndrome, etc.) and/or who were involved in official competitive swimming. We required parents to provide their informed consent for their children's participation in the study, and required additional consent and participation of one of the parents for each eligible child. The local ethics committee granted approval for the study procedures that were used (B.U.N. 143201942643).

A total of 134 children (56% boys; *M* age = 7.1, *SD* = 1.1 years) were eligible and agreed to participate to the present study together with one of their parents (71.6% mothers). Our study sample included 48 6-year-olds (35.8%), 42 7-year-olds (31.3%), 22 8-year-olds (16.4%) and 22 9-year-olds (16.4%). All children had some experience in swimming lessons (i.e., one or two times a week depending on the local organization), varying between half a year up to 6 years (*M* = 2.19, *SD* = 1.28 years).

Procedure and measurements

We collected data between October 2018 and February 2019 for 134 distinct child-parent dyads. Nine out of the 134 participating parents provided the required demographic information as well as their perceptions of the aquatic skills of two or three of their children (i.e., eight parents and one parent, respectively). Measurements took place at the participating children's respective swimming school facilities. All children first completed the 'Pictorial Scale of Perceived Water Competence' (PSPWC; Morgado et al., 2020) to assess their level of self-perceived aquatic skills (see details below). Subsequently, they performed an 'Actual Aquatic Skills Test' (AAST) in the water of the swimming pool, using the exact same 17 items included in the PSPWC. The order of completing the PSPWC and then the AAST was the same for all children. The AAST was administered by two final-year physiotherapy students completing their master's thesis on this topic, with one of them being a qualified swimming instructor (i.e., swimming coach with a European Qualifications Framework (EQF) level 1 certificate). Together with their supervisor, who had more than 30 years of experience in swimming and sport pedagogy (i.e., swimming coach with an EQF level 4 certificate), these test administrators performed an interactive pilot interrater reliability session with two children outside the study sample in order to reach mutual agreement on the organization and specific assessment method of the AAST. Finally, a parent of each child participating in the present study also had to complete the PSPWC to assess their personal perception of their child's aquatic skills, doing so in a different room from their child to avoid a mutual influence on test results. By analogy, parents were not allowed to watch their child while completing the AAST in the swimming pool.

Pictorial Scale of Perceived Water Competence (PSPWC). The PSPWC is a pictorial questionnaire, still in development at the time of data collection. Its

development was driven by an international reference group consisting of academic members from six different countries (i.e., Australia, Belgium, Canada, England, Finland, and Portugal) with expertise in swimming, aquatic skills and/or perceived competence. The validation of this assessment tool is currently ongoing (De Pasquale et al., 2020; Morgado et al., 2020). The PSPWC aims to measure the child's (or others') perceptions of a child's physical water competence, based on 17 different aquatic situations that vary in complexity and the associated required skills. For the purpose of the present study, the PSPWC was completed separately by both the child and one of their parents. A presentation of the different items included in the PSPWC is available in Table 1. For each of the aquatic skills included ($N = 17$), the scale depicts three different levels of skill performance. Both the child and parent were instructed to choose the picture that best resembled how the child would actually perform the aquatic skill when asked to execute the test item in the water. Choosing the 1st level (i.e., picturing a child being unable to execute the aquatic skill) yielded a score of '0'. When choosing the 2nd level (i.e., picturing a child being partly able to execute the aquatic skill, and thus in progress) or the 3rd level (i.e., picturing a child being fully able to execute the aquatic skill), a score of '1' or '2' was awarded, respectively (Morgado et al., 2020). Since this same scoring procedure was applied to each of the 17 different aquatic skills, the total score of the PSPWC assessment ranged between 0 and 34.

[Insert Table 1 about here]

Actual Aquatic Skills Test (AAST). All participating children were also asked to perform an aquatic skills test in the swimming pool to assess their actual level of physical water competence when executing the same 17 aquatic skills of the PSPWC in

the water, with a temperature of about 28-29°C. One test item was performed in shallow water (i.e., water up to knee height in standing position), seven test items had to be performed in deep water (i.e., head completely submerged in standing position) and nine test items in a water depth in between (i.e., water at hip to shoulder level in standing position). Each time, the same test leader (i.e., the assessor, who was also a certified swimming coach as mentioned above) was responsible for guiding the child in performing the AAST in the water and for awarding the child's actual aquatic skill score per test item, while the other test leader (i.e., the assistant observer) noted each of these scores on the data recording form standing on the edges of the pool. We used a plastic card showing the different PSPWC test items as a visual support when a child seemed not to fully understand the execution of a test item. When even the use of this card was not sufficient for the child to reach a full understanding, the assessor self-demonstrated the (3rd level of the) test item. Children were asked to perform each single test item or aquatic skill as well as possible, according to their own ability. A child was allowed to repeat the execution of a test item when it was clear that the requested aquatic skill was not correctly understood or when the child was thought to be absent-minded or distracted due to environmental factors. The score of a child's final execution of each aquatic skill was used for data analysis. Despite being present in the water, the assessor was not allowed to provide any physical support when the child was executing each of the 17 different test items. Based on the observed performance per test item, a score of '0', '1' or '2' was granted to the child by the assessor in line with the abovementioned three aquatic skill levels and the scoring procedure of the PSPWC (i.e., a score of '0' meaning unable, '1' meaning partly able, and '2' meaning fully able to execute the aquatic skill). Summing all single test item scores together, the total score of this AAST also ranged from 0 to 34.

Statistical analysis

We analyzed data using IBM SPSS Statistics for Windows (version 27.0, IBM Corp.: Armonk, NY, USA), with the statistical significance level being set at $p < 0.05$. We first analyzed the raw test scores of the PSPWC/AAST instrument to ensure sufficient internal consistency of the 17 test items before the items were summed. As such, we calculated a Cronbach's α for the PSPWC (as completed by both the participating children and by one of their parents) and for the children's AAST outcomes. We provided descriptive statistics (i.e., means and standard deviations) of the total scores on the PSPWC and the associated AAST. We conducted a three-way repeated measures ANCOVA to compare children's actual, self-perceived and parent-perceived level of aquatic skill (as the within-subjects factor) according to sex (i.e., boys vs. girls) and age group (6-7 year-olds vs. 8-9 year-olds), controlling for their years of swimming school experience. Significant interaction effects were further examined depending on the between-subjects factor(s) involved, and we applied the Bonferroni procedure for multiple comparisons when needed.

Results

As shown in Table 2, all three types of aquatic skill assessment (i.e., children's actual aquatic skills by administration of the AAST, children's self-perceived aquatic skills on their completion of the PSPWC, and parent-perceived children's aquatic skills as parents reported on the PSPWC) showed good to excellent internal consistency for all 17 test items (Cronbach's α always > .70 and ranging between .871 and .932). Thus, the total scores of both the AAST and PSPWC could be used as the main outcome variable for assessing and comparing the children's actual, self-perceived, and parent-

perceived and aquatic skill levels. Descriptive statistics per type of aquatic skill assessment according to children's sex and age group are presented in Table 3.

[Insert Tables 2 and 3 about here]

We investigated the differences, and thus the degree of (dis)agreement, between the total scores of the AAST and PSPWC (as completed by both the participating children and by one of their parents) using a three-way repeated measures ANCOVA. As children's years of swimming school experience was a significant covariate (F = 22.184; $p < 0.001$; $\eta_p^2 = 0.147$), we adjusted for it. No main or interaction effects regarding sex occurred. In addition to a main effect for type of assessment (F = 12.421; $p < 0.001$; $\eta_p^2 = 0.163$) and children's age group (F = 5.783; $p < 0.018$; $\eta_p^2 = 0.043$), we found a significant interaction effect between both of these factors (F = 4.639; $p <$ 0.011; $\eta_p^2 = 0.068$). Looking more closely at the differences in total scores according to the type of aquatic skill assessment within the group of 6-7 year-olds (F = 12.899; $p <$ 0.001; $\eta_p^2 = 0.068$), we found children's AAST performance value to be significantly higher than their self-perceived and parent-perceived aquatic skill levels ($p = 0.007$ and $p < 0.001$, respectively). Also, the 6-7 year-old children's self-completed PSPWC total score significantly exceeded the same outcome on the PSPWC as completed by the parents ($p < 0.001$). A closer examination of the differences according to the type of aquatic skill assessment among the 8-9 year-old children (F = 10.374; $p < 0.001$; $\eta_p^2 =$ 0.336) showed that their AAST performance was also significantly higher than both the self-perceived and parent-perceived aquatic skill levels ($p = 0.001$ and $p < 0.001$, respectively). However, we did not find a significant difference between total scores of

the children's self-completed PSPWC compared to the parent-completed PSPWC within the age group of 8-9 year-olds (see Figure 1).

[Insert Figure 1 about here]

Discussion

Previous research on children's actual and perceived motor competence has mainly been performed in the context of motor skills executed on dry land. Given the importance of child and parent perceptions of a child's actual aquatic skill level in relation to water safety, we first demonstrated in this exploratory study the internal consistency of the Pictorial Scale of Perceived Water Competence (PSPWC; Morgado et al., 2020) as a new assessment tool covering 17 different fundamental aquatic skills for children to be water safe. We then compared child-completed and parent-completed PSPWC total scores as estimates of self-perceived and parent-perceived aquatic skill competence to a perfectly aligned 'Actual Aquatic Skills Test' (AAST) in the water, in order to examine the differences between young children's actual aquatic skills and estimates of their self-perceived and parent-perceived aquatic skill competence.

Regarding children's self-perception of their actual aquatic skill levels, our results showed that the total score on the self-completed PSPWC was lower than their total score obtained on the AAST. Regardless of sex, however, the degree of disagreement between both outcome measures was rather limited both in the 6-7 year-old children ($\Delta = 1.43$) and the 8-9 year-old children ($\Delta = 1.62$), of whom the latter registered higher scores for both types of assessment. Taking into account the score range of our perfectly aligned assessment tools (see Estevan & Barnett, 2018 for a discussion on the importance of aligning instruments), it can be suggested that these

young children generally hold a fairly realistic estimate of their aquatic skills. Yet, our participants' somewhat lower perceptions are in contrast to recent findings from Costa et al. (2020). Focusing on those skills identified by the literature as important for drowning, these authors reported a divergence in 6-10 year-old children's actual and perceived aquatic competence, with younger children (aged 6-7 years) being more likely to overestimate their aquatic skill levels, especially if evaluated under more complex conditions (i.e., when wearing clothes in the water). Although controlling for the years of swimming school experience in the present study, it should be noted that all participating children were already enrolled in an educational swimming program built around both fundamental and survival-related aquatic skills. Therefore, future research in the aquatic skill context on the differences and/or the association between children's actual and perceived competence (taking their age and sex into account) should apply a broader recruitment strategy (e.g., through elementary schools), preferably also considering participants' unique ecological system (e.g., their parents' engagement and experiences in aquatic activities, the presence of pools or natural water in children's everyday living environment, etc.). Investigators of children's land-based self-perceived and actual motor skills have suggested that these self-perceptions impact on physical activity participation and behavior, in that children with higher perceived motor competence are generally more physically active (Robinson et al., 2015; Stodden et al., 2008). Likewise, children's self-perception of their aquatic skill level may influence their specific water-based movement and activity behavior as well as their motivation to participate in aquatic recreation. However, this participation brings added risks that make accurate estimates of skill competence (both by the children themselves as by significant others) critically important, especially in an aquatic environment, given that children tend to search for more challenging activities while playing (Brussoni et al.,

2012). Although never without danger, undertaking those more challenging or risky activities is considered essential to ongoing physical development (Brussoni et al., 2015).

In this study, children's actual aquatic skill levels (i.e., AAST total score) were also compared against the parental perceptions of their child thereof (i.e., total score on the parent-completed PSPWC). In the aquatic literature, Mercado et al. (2016) previously reported a weak correlation between parental perceptions and children's actual aquatic skills. These authors also found that the strength of the correlation between the children's self-perceptions and the parental perceptions varied according to the child's actual skill level in the water. The findings of Mercado et al. (2016) indicated that both children and parents found it harder to accurately estimate a child's aquatic skill level when the child was less skilled. In contrast, also using the PSPWC, De Pasquale et al. (2020) found no association between 4-8 year-old children's and their parent's perceptions of their swimming ability and reported that swimming level (i.e., beginner, intermediate or squad category, based on a standardized ranking system created by the researchers) was positively associated with children's self-perception but not with the parent's perceptions. De Pasquale et al. (2020) concluded that children have a better understanding of their swim competence than their parents do, suggesting parent education is needed. In the present study, we found that the total score on the parent-completed PSPWC was significantly below the child-completed PSPWC total score (and thus also inferior to children's AAST performance value) in the age group of 6-7 year-olds. However, in the 8-9 year-old children of our study sample no significant difference between the parent-completed and the child-complete PSPWC occurred. This means that the parental degree of disagreement relative to children's actual aquatic skill levels is similar in somewhat older children (8-9 years; $\Delta = 1.39$), but more pronounced

in younger peers (6-7 years; $\Delta = 4.10$). Our overall finding of a lower parental estimate in view of children's actual aquatic skill levels (as assessed by means of the AAST) contradicts with results obtained from previous research, in which parents seemed to overestimate their child(ren)'s actual aquatic skill level(s) (Langendorfer, 2011; Morrongiello et al., 2013; Stanley & Moran, 2017). In the study of Morrongiello et al. (2013), for example, children were following a swimming series of 10 lessons. Their parents had to complete a 'swim ability checklist' twice, assessing their child's actual aquatic skills at the end of the 3rd lesson and before the start of the 10th and final lesson. The parental perceptions of the children's aquatic skills did not completely correspond with their actual aquatic skills, indicating that parents overestimated what their children had learned. However, the number of errors parents made in reliably judging their child's swim ability decreased after a couple of swimming lessons and decreased even more when parents were informed about their child's individual progress in aquatic skill development during the lesson series (Morrongiello et al., 2013). Langendorfer (2011) demonstrated that parents are more likely to think their child is sufficiently aquatically skilled or can swim after following some swimming lessons even though this might not be justified. This latter author suggested that parents made an 'undocumented assumption' about their children's actual aquatic skillfulness. Similarly, other studies have reported that parents often underestimate the degree of supervision that children need in the context of aquatic recreation (Moran, 2009; Stanley & Moran, 2017). Hence, as also stated earlier by De Pasquale et al. (2020), it is important to educate parents on how to correctly assess their children's actual aquatic skill level (Morrongiello et al., 2013; Stanley & Moran, 2017).

A major strength of our exploratory study was that we filled a research gap by evaluating and comparing children's actual and perceived aquatic skill levels as well as

the difference between their actual and parental perceived aquatic skills. Moreover, we based our assessments and comparisons on a newly developed and user-friendly pictorial scale (PSPWC; Morgado et al., 2020), and also translated the 17 fundamental and survival-related aquatic skills of the PSPWC into an 'Actual Aquatic Skills Test' (AAST) for children to perform in the water, which is different from more general assessments of aquatic performance (e.g., swimming distance tests). As such, our assessments of perceived and actual competence were perfectly aligned (Costa et al., 2020; Bardid et al., 2019; De Meester et al., 2020; Estevan et al., 2019). This method is recommended to future researchers and practitioners seeking to better understand and monitor children's actual and perceived aquatic skills across development in efforts to assure water safety and encourage aquatic recreation in view of lifelong physical activity (Langendorfer, 2015; Audrey et al., 2012; Hulteen et al., 2018). Using a pictorial scale versus a traditional written questionnaire represents another strength of the present study in that younger children can then visualize and more accurately respond to descriptions of the different aquatic skill levels per test item as demonstrated by De Pasquale et al. (2020) in their analysis of PSPWC self-perception reliability. Yet, a future research endeavor could be to further investigate test-retest reliability of both instruments used. Furthermore, there remains need for more research on children's actual and perceived skill competence in various movement contexts, which also includes the aquatic environment, especially when considering the roles of age and sex to gain more insight into (the development of) children's (and significant others') perception of a child's actual motor/water competence level (Estevan et al., 2018).

Limitations and Directions for Future Research

A main limitation of our research was our exclusive focus on the physical/motor competence of children in an aquatic environment, using the AAST to assess their

actual skill levels. The concept of water competence in relation to drowning prevention is much broader than these 17 test items, and its assessment could be expanded to one's knowledge of local hazards as well as appropriate attitudes and values in relation to an aquatic environment. In their book on aquatic readiness, Langendorfer and Bruya (1995) introduced the term 'water competence' as *the "proficiency in a wide variety of aquatic skills, knowledges, and values"* (p2). Future research will need to combine the assessment (both actual and perceived) of aquatic skills and the perception of risk affordances in different aquatic environments, such as indoor swimming versus open water circumstances. After all, one's water competence is largely influenced by conditions of the task-specific aquatic environment (e.g., water temperature, depth, current). The particular skills demonstrated to be effective in guaranteeing water safety and survival in one aquatic environment may not automatically transfer to another one (Quan et al., 2015; Stallman et al., 2017).

Another limitation is that 71.6% of the parents completing the PSPWC on the perceived aquatic skills of their child(ren) were female/mothers, making generalization to larger male parent samples more questionable as fathers were underrepresented in the present study sample. However, in order to be able to compare the estimates of mothers and fathers regarding children's aquatic skill levels, both parents of one and the same child should be included in future studies on the topic.

The fact that all participating children were already involved in a swimming school (located in Flanders and the Brussels Capital Region, Belgium), might be considered as another drawback of the present study, since this narrow sub-population might have been more self-aware of their aquatic skill competence. In particular, those children and parents not being part of such a program may be those who are most at risk for misaligned perceptions in view of children's actual skill competence in the water.

Social patterning and privileges in sport education, and in swimming in particular, have been cited as problematic (Audrey et al., 2012). Earlier experience in aquatics (or the lack thereof) both among children and their parents should thus be considered in future research in order to test the hypothesis that (a lack of) previous experience with swimming and/or moving in an aquatic environment might influence the self-perception or parental perception of children's skills.

Conclusion

To summarize, this exploratory study contributed to the ongoing validation of the Pictorial Scale of Perceived Water Competence (PSPWC; Morgado et al., 2020) and represents a key advance in assessing both children's actual and perceived aquatic skills as well as their mutual relationship and degree of agreement, using aligned perception and competency instruments. We found a high internal consistency of the 17 included test items, meaning that the total scores of both the PSPWC and the AAST can be used as a reliable main outcome variable for assessing perceived and actual aquatic skill levels, respectively. Further, our analysis of within-subject differences between the total scores on the AAST performed by the children and the PSPWC completed by both the children and one of their parents, showed that both parties provided a lower estimate when compared to the child's actual aquatic skill level. This degree of disagreement against the AAST was more pronounced among parents than children aged 6-7 years, whereas the parental estimate was found to be similar to that of children aged 8-9 years. Therefore, children's actual aquatic skill level should be considered an interesting and necessary consideration in future research on perceived competence (both by the children themselves and significant others) in a water-based movement context.

The findings from our exploratory study may form the basis of future research into aquatic skills, water competence and water safety. Notwithstanding this research,

future investigators should focus on a broader recruitment with sufficient participants of both sexes in different age groups from different (cultural/educational) backgrounds and with attention to a broader range of aquatic skills and contexts. A promising research avenue is to study the clustered data on different related concepts: actual aquatic skills, perceived aquatic skills, perceived risk of danger and risk-taking propensity. It can be interesting to analyze children's and (pre)adolescents' profiles combining these outcomes depending on (relatively) high(er) or low(er) scores and to examine in more detail the distribution across clusters related to age, sex and aquatic experience. The cluster most at risk for drowning would likely consist of those children and (pre)adolescents, who overestimate their own aquatic skills and underestimate drowning risks. Longitudinal research on the topic is also encouraged.

Even though the PSPWC was developed to use among children for assessing their perceived aquatic skills, it also offers possibilities to be used among adult caregivers, such as parents, supervisors and educators. Moreover, these adults' perceptions of children's aquatic skill levels are vital in order to follow and stimulate a developmental approach and safe progression in water competence and associated aquatic children's activities. In efforts to develop children's water safety awareness, it may be important to let them take and learn to manage risks under supervision, as gradually stimulating anxiety and emotional engagement in learning water competence is an important safety principle (Guignard et al., 2020). Therefore, aquatic educators should focus on relevant transferable skills and self-regulatory behaviors for children while being in, on and around water. It is necessary for them to function and be safe in a more dynamic aquatic environment outside the quite stable conditions of an indoor swimming pool (Guignard et al., 2020). Education and transfer of water competence (i.e., aquatic skills, knowledge, and values; Langendorfer & Bruya, 1995) still requires a

professional and holistic approach to cope with various aquatic environments, including indoor and outdoor swimming pools, lakes, rivers and oceans (Guignard et al., 2020). Therefore, aquatic learners require a wide repertoire of self-regulatory behaviors, such as awareness of obstacles, water properties and potential dangers, floating and moving depending on the context, accurate decision making, and emotional control. These additional focus points can be thought and developed both in school curricula and extra-curricular water recreation training. In addition, there is a concomitant need for effective initiatives to raise parental awareness and education in this respect.

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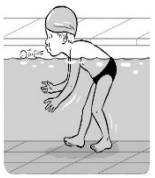
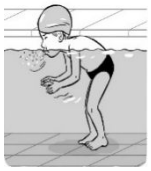
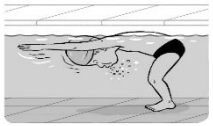
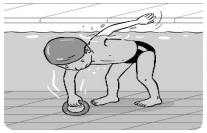
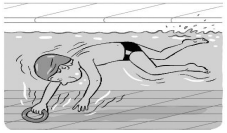
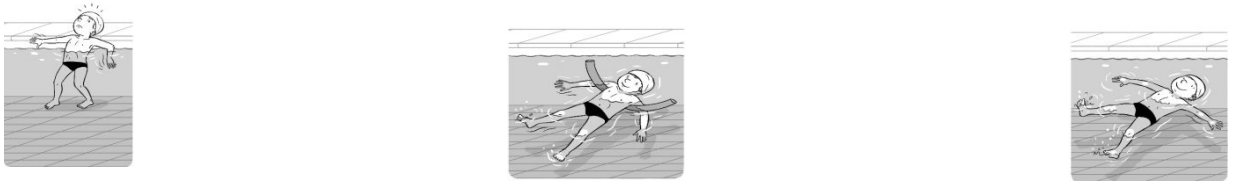
Table 1. Pictures of the three different levels per aquatic skill or test item included in the 'Pictorial Scale of Perceived Water Competence' (PSPWC, $N = 17$).

Level Aquatic skill or test item	Unable to execute the aquatic skill '0'	Partly able to execute the aquatic skill (in progress) '1'	Fully able to execute the aquatic skill '2'
1. Moving forward using hand			
2. Walking in water			
3. Blowing bubbles under water			
4. Catching objects under water			

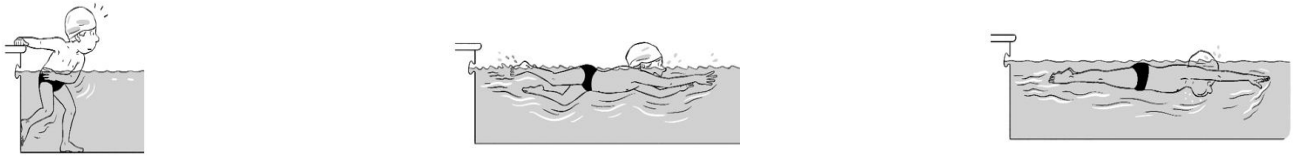
5. Floating on the back



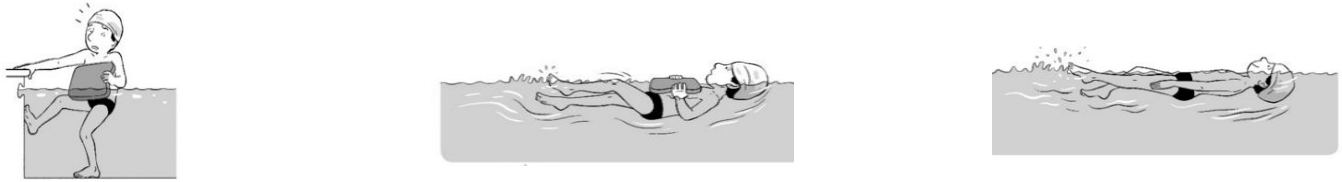
6. Floating on the front

7. Water entry by gliding

8. Pushing from the wall and gliding under water



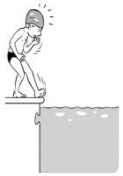
9. Leg propulsion on the back



10. Leg propulsion on the front



11. Water entry by jumping



12. Water entry by diving



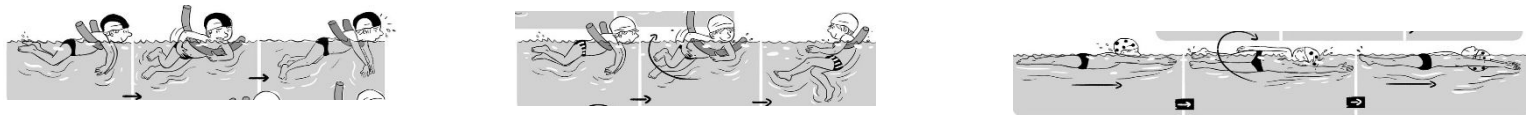
13. Water exit by climbing out



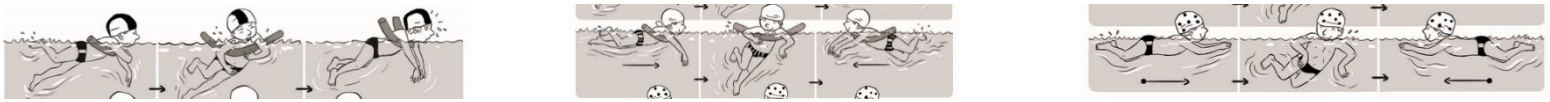
14. Vertical treading water



15. Turning from the front to the back in aligned position



16. Changing direction while swimming on the front



17. Turning from the back to the front or transverse rotation

See http://hdl.handle.net/2268/246746 for the most recent test manual including all pictures of the Pictorial Scale of Perceived Water Competence (PSPWC; Morgado et al., 2020).

Table 2. Internal consistency per type of aquatic skill assessment.

Test statistic	AAST	PSPWC	
		Self-completed	Parent-completed
Cronbach's α	.932*	.871*	.932*

AAST: Actual Aquatic Skills Test; PSPWC: Pictorial Scale of Perceived Water Competence.
*Cronbach's $\alpha > .70$.

Table 3. Descriptive statistics per type of aquatic skill assessment according to children's sex and age group.

	CHILDREN						PARENTS	
	Girls (*n* = 59)		Boys (*n* = 75)		ALL (*N* = 134)		(*N* = 134)	
Type of aquatic skill assessment	6-7 year-olds (*n* = 44)	8-9 year-olds (*n* = 15)	6-7 year-olds (*n* = 46)	8-9 year-olds (*n* = 29)	6-7 year-olds (*n* = 90)	8-9 year-olds (*n* = 44)	6-7 year-old children (*n* = 90)	8-9 year-old children (*n* = 44)
Actual aquatic skill level° (AAST)	30.45 ± 5.38	33.40 ± 1.06	30.74 ± 5.51	33.38 ± 1.02	30.60 ± 5.42	33.39 ± 1.02	-	-
Self-perceived aquatic skill level° (PSPWC, Self-completed)	28.30 ± 5.72	31.73 ± 2.69	30.00 ± 5.29	31.79 ± 3.01	29.17 ± 5.54	31.77 ± 2.87	-	-
Parent-perceived aquatic skill level° (PSWPC, Parent-completed)	-	-	-	-	-	-	26.50 ± 6.65	32.00 ± 2.53

N/n = number of participants; ° Score range: 0-34; AAST: Actual Aquatic Skills Test; PSPWC: Pictorial Scale of Perceived Water Competence.

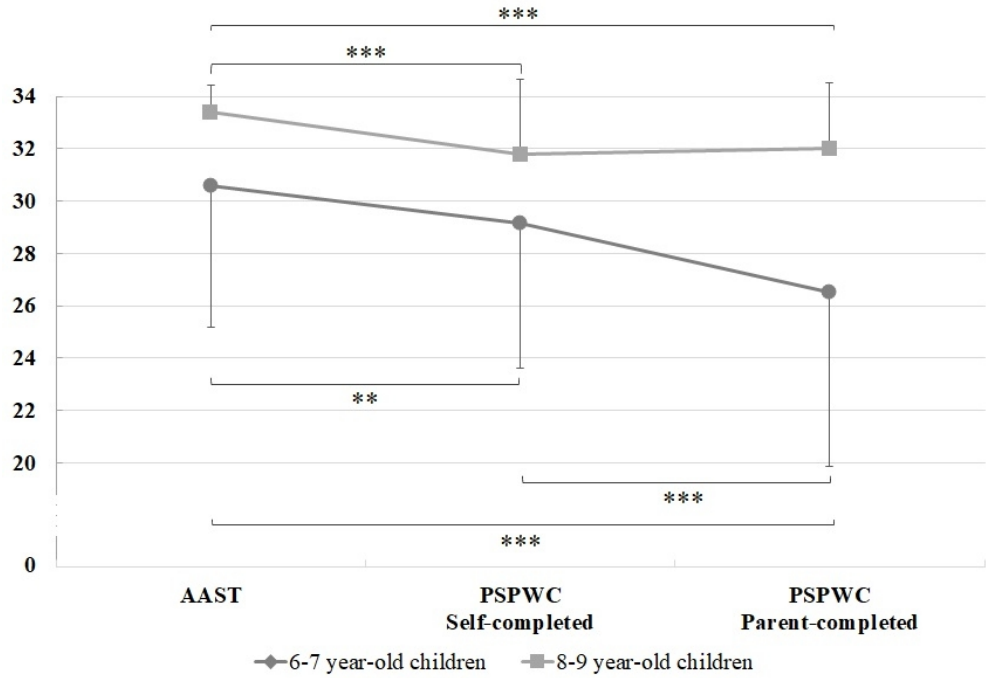


Figure 1. Visualisation of the INTERACTION EFFECT between type of aquatic skill assessement (i.e., Actual Aquatic Skills Test (AAST) vs. Self-completed and Parent-completed Pictorial Scale of Perceived Water Competence (PSPWC); within-subjects factor) and children's age group (i.e., 6-7 year-olds vs. 8-9 year-olds; between-subjects factor). Asteriks indicate a significant difference between the totals scores within each individual age group (with ***$p \leq 0.001$ and **$p < 0.01$).

225x157mm (96 x 96 DPI)