A Longitudinal Examination of the Accuracy of Perceived Physical Competence in Middle Childhood

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Children who underestimate their physical abilities have lower motivation, higher anxiety, and lack of understanding as to why they may be succeeding or struggling in sports settings, which can result in withdrawal from physical activities. Theoretically, middle childhood is a time when perceptions of physical competence (PPC) become more accurate as children develop the cognitive capacity to interpret new sources of feedback and develop a realistic sense of their physical abilities. The purpose of this study was to investigate the extent to which accuracy of PPC changed from grade 2 to grade 4. Participants were 238 boys and girls ($M_{\text{age}} = 7.8$ yrs) from eight participating elementary schools in Victoria, British Columbia, Canada. The Test of Gross Motor Development–Second Edition was used to assess motor skills. PPC were assessed using the Pictorial Scale of Perceived Competence and Social Acceptance for Young Children (for grade 2) and the Self-Perception Profile for Children (for grades 3 and 4). Results revealed that participants who underestimated or overestimated their physical competence in grade 2 saw an improvement in accuracy, and, by grade 4, had similar accuracy scores to their peers who were considered ‘accurate’ estimators. These results reinforce theory that suggests PPC become more accurate in middle childhood.

Keywords: children, motor development, perception

Developmental experts have theorized that during the transition from early to middle childhood, perceptions of physical competence will become more accurate (Harter, 2012b; Robinson, Stodden, Barnett, & Lopes, 2015; Stodden et al., 2008). Understanding this process is important because boys and girls who underestimate

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their physical abilities have markedly higher anxiety, lower motivation, and little understanding as to why they may be succeeding or struggling in a sport setting compared to their average or overestimating peers (Weiss & Ambrose, 2005; Weiss & Horn, 1990). Children who underestimate their physical competence are also likely to discontinue participation in sports or physical activity (Stodden et al., 2008; Weiss & Horn, 1990).

Perceptions of competence are an individual's thoughts, attitudes, feelings, or beliefs about their personal abilities in regard to specific skill domains (e.g. academic, athletic, social) (Horn, 2004). During the early part of middle childhood (~5–7 years), self-perceptions are often unrealistically positive as children at this age do not yet distinguish between their 'real' and 'ideal' self, meaning they do not feel the need to strive toward an ideal self, as they already perceive themselves to be 'the best' (Horn, 2004). For example, on average, kindergarten ($M_{\text{age}} = 5.8$ years) and grade 2 ($M_{\text{age}} = 7.8$ years) boys and girls scored between 18/24 and 21/24 for perceptions of physical competence (Crane, Foley, Naylor, & Temple, 2017). Having inflated beliefs at this age is not detrimental because children who do not yet have accurate perceptions often equate effort or mastery attempts with motor skill competence (Harter & Pike, 1984). Therefore, even if a child has poor motor skills, they are more likely to continue to participate in an activity if they believe they are trying hard, ultimately affording them opportunities to develop the skills necessary to continue and expand their participation (Harter & Pike, 1984).

As children enter the later years of middle childhood (~7–10 years), they interact with increasingly diverse social environments (e.g. exposure to new sources of feedback from teachers, coaches, test scores) (Horn, 2004; Kipp & Weiss, 2013). This, coupled with cognitive development that includes the ability to take another's perspective and compare performances between peers (Eccles, 1999), means that children at this age will likely develop more accurate perceptions of competence (Horn, 2004; Kipp & Weiss, 2013). Thus, perceptions that were once inflated may begin to decrease. Findings among three cohorts of children who were recruited in grades 1, 2, and 4 and followed for three years supports this trajectory of change (Wigfield et al., 1997). Significant decreases in the children's perceptions of sports competence were observed for each cohort i.e. from grades 1–3, grades 2–4, and grades 4–6. Although Wigfield et al. did not report ages in their study, based on typical age of school entry in Michigan, where their study was conducted, these grades equate to roughly 6–8 years, 7–9 years, and 9–11 years old (National Center for Education Statistics, 2018). In contrast to these reported decreases, using a measure of perceptions of motor competence, van Veen and colleagues (2019) reported stable perceptions for boys and girls aged 8–11 years across a one-year period.

Wigfield et al. also found that boys had more positive competence beliefs than the girls in their study. This trend toward boys reporting higher levels of perceived physical competence than girls is supported by several cross-sectional studies examining perceptions of physical competence in middle childhood (Barnett, Ridgers, & Salmon, 2015; Liong, Ridgers, & Barnett, 2015; Pesce, Masci, Marchetti, Vannozzi, & Schmidt, 2018; Rudisill, Mahar, & Meaney, 1993). What is unclear, however, is the degree to which these differences in perceptions reflect differences in skill levels. Liong et al.'s (2015) study is particularly interesting in this

regard as the girls perceived their object control skills to be significantly lower than the boys', and a measure of their actual object control skills showed the girls were significantly and meaningfully less proficient than the boys (girls' *M* object control score 26.7/48, compared with 32.3/48 for boys).

Increasing accuracy of perceptions of physical competence during middle childhood is said to be the result of an improvement in motor skills and a decrease in inflated early childhood perceptions of physical competence (Harter, 2012b; Robinson et al., 2015; Stodden et al., 2008). The best evidence of improvement in motor skills during childhood comes from longitudinal research which has shown that motor skills improve during early childhood (Crane, 2016; Crane et al., 2017; Westermeyer, 1989), during middle childhood (D'Hondt et al., 2013; Temple & Foley, 2017), and as children transition from early to middle childhood (Crane, 2016; Westermeyer, 1989). However, the pattern of development is not identical for boys and girls (Barnett et al., 2015; Liong et al., 2015; Temple, Crane, Brown, Williams, & Bell, 2016). Boys consistently demonstrate higher object control skill scores than girls as well as an earlier acquisition of object control skills (Barnett et al., 2015; Barnett, van Beurden, Morgan, Brooks, & Beard, 2010; Field & Temple, 2017; LeGear et al., 2012; Temple et al., 2016). For example, 60 percent of 5½-year-old boys can throw proficiently, while girls, on average, do not reach the same level of proficiency for three more years (Payne & Isaacs, 2016). While there is some evidence that girls demonstrate higher locomotor proficiency than boys do (Barnett et al., 2015; LeGear et al., 2012; Liong et al., 2015; Robinson, 2011), recent review evidence suggests that the sex of a child is not associated with locomotor skill proficiency (Barnett, Lai, et al., 2016).

While the relationship between perceptions of physical competence and motor skill proficiency has been examined often (Barnett, Morgan, Van Beurden, Ball, & Lubans, 2011; Barnett, Morgan, van Beurden, & Beard, 2008; Barnett et al., 2015; Crane, Naylor, Cook, & Temple, 2015; Farmer, Belton, & O'Brien, 2017; Lopes, Saraiva, Gonçalves, & Rodrigues, 2018; Spessato, Gabbard, Robinson, & Valentini, 2013; Wrotniak, Epstein, Dorn, Jones, & Kondilis, 2006), the accuracy of perceptions of physical competence remains relatively under-researched. Understanding accuracy of perceptions is important because, as Weiss and Horn (1990) found among girls in middle childhood, those who underestimated their skill level had higher anxiety scores, preferred less challenging activities, and they exhibited higher perceived external control than their overestimating or average peers did. Underestimating boys in the same study had high levels of perceived unknown control, which reflected a lack of understanding of the sources contributing to their physical competence.

Through learning and practice, we expect that motor skills will become more proficient during middle childhood. Further, as children's cognitive abilities develop in middle childhood and they are exposed to increasing sources of feedback we expect their perceptions of competence to decrease and become more accurate. The accuracy of these perceptions is associated with particular psychological states such as anxiety (Weiss & Horn, 1990). What is unclear from the available literature is when children become more accurate in their perceptions of physical competence and whether this pattern differs between boys and girls. Therefore, the aim of this longitudinal study was to investigate if boys' and girls' perceptions of physical competence become more accurate from grade 2 to grade 4.

We hypothesized that 1) locomotor skills and object control skills would increase, and perceptions of physical competence would decrease; 2) boys would demonstrate higher object control skill levels and higher perceptions of physical competence in each grade; 3) girls would demonstrate higher locomotor skills in each grade; and 4) the accuracy of perceptions of physical competence would increase for both boys and girls from grade 2 to grade 4.

Methods

We used a longitudinal study design to examine the accuracy of perceived physical competence of children from grade 2 to grade 4. The University of Victoria Human Research Ethics Board as well as the participating school district granted approval for this study. Statistics Canada census data indicates that as of 2016, families in Victoria, British Columbia, where the current study took place, had a median income equivalent to that of the national median (Statistics Canada, 2019). Additionally, in the participating school district, rates of vulnerability akin to school readiness are lower than, or equivalent to, other British Columbia school districts (Kershaw, Irwin, Trafford, & Hertzman, 2005).

It should be noted that we have previously published data for these grade 2 children in a paper examining change in the relationship between motor skills and perceptions of physical competence from kindergarten to grade 2 (see Crane et al., 2017). The current study builds on the Crane et al. study by examining change from grade 2 to grade 4, and further provides a more sophisticated analysis by tracking change in these relationships grounded in how children were perceiving their proficiency in grade 2.

Participants

Children in grade 2 at one of eight consented public elementary schools in British Columbia, Canada were recruited in two cohorts (2012–2013 and 2013–2014). Each cohort was followed for two additional years (grade 3 and grade 4). Each year's data were collected as close to the previous year's test date as allowable by the participating school's schedule. Parents provided written informed consent at the beginning of each data collection year, and children provided written assent.

Children were included in this study if there were complete motor skills and perceptions of physical competence data for grade 2, 3, and 4. Of the 419 participants who consented in grade 2, 238 (52%) had complete data for grade 2, 3, and 4 and were included in the final longitudinal sample. Participants were $n = 238$ children (54% female; M_{age} girls = 7.8 years, $SD = 4.2$ months; M_{age} boys = 7.8 years, $SD = 4.3$ months).

We examined the effect of experimental mortality in the longitudinal sample by comparing the cross-sectional samples in each grade to the longitudinal locomotor and object control skills and perceptions of physical competence scores. Cross-sectional comparison participants from each grade were: $n = 181$ (grade 2), $n = 201$ (grade 3), and $n = 179$ (grade 4). Independent samples t-test results indicated a significant difference between the cross-sectional (Mean = 28.75,

SD = 6.58) and longitudinal (Mean = 31.16, SD = 4.85) locomotor skills scores for grade 2 participants ($p < .001$). No other significant differences were found.

Measures

The Test of Gross Motor Development–Second Edition (TGMD-2; Ulrich, 2000) was used to assess motor skills. The TGMD-2 is a 12-item, norm- and criterion-referenced, developmental fundamental motor skill test that includes two subscales: (1) locomotor skills (run, gallop, slide, hop, jump, and leap) and (2) object control skills (dribble, catch, strike, throw, roll, and kick). Each skill on the locomotor or object control skill subscale is assessed individually and is made up of 3–5 components (e.g. when a child jumps, his or her “preparatory movement includes flexion of both knees with arms extended behind body”). Every time a child performs a skill component according to the TGMD-2 criteria he or she is awarded a ‘1’. Children receive a ‘0’ if the criterion is not met. The score range of each subscale is 0–48. The TGMD-2 is validated for children 3.0 to 10.11 years of age. Test-retest reliability is reported at .94 (locomotor) and .96 (object control) for 6- to 8-year-old children, and .86 (locomotor) and .84 (object control) for 9- to 10-year-old children (Ulrich, 2000). Criterion-prediction validity was established through moderate to strong partial correlations (locomotor = .63; object control = .41) and the goodness-of-fit index was reported at .96 (Ulrich, 2000).

Perceptions of physical competence were assessed in grade 2 using the Pictorial Scale of Perceived Competence and Social Acceptance for Young Children (Harter & Pike, 1984) and the Self-Perception Profile for Children in grades 3 and 4 (Harter, 1982, 2012a). The Pictorial Scale is a 24-item questionnaire that contains four subscales (6 items per subscale): cognitive competence, physical competence, peer acceptance, and maternal acceptance. The score range for each item is 1–4, resulting in a total score range of 24–96. This scale is accompanied by a gender specific picture book that depicts either a boy or girl performing the task associated with each item. The child is shown two pictures for each item; one of a child who is proficient in the task (e.g. skipping) and one a child who is not. The pictures are described to the child (e.g., “This boy is good at skipping and this boy is not very good at skipping”). The child selects which image/statement is most like them and if their answer is ‘really true’ (e.g., it is really true that I am good at skipping) or ‘sort of true’ (e.g., it is sort of true that I am good at skipping). The grade 1 and 2 version of the Pictorial Scale was used for the grade 2 children in this study. For grade 2 children, internal consistency reliability for the competence scale was .80 for the combined scale and .62 for the physical subscale (Harter & Pike, 1984). Convergent validity for the physical subscale was established by determining that children were able to readily provide concrete reasons for their competencies (e.g. “Somebody taught me to climb the jungle gym”).

In grades 3 and 4, the Self-Perception Profile for Children (Harter, 1982, 2012a) was used. The Self-Perception Profile for Children (Harter, 2012a) is a 36-item self-report survey for children in grades 3–8 that contains six subscales: scholastic competence, social competence, athletic competence, physical appearance, behavioral conduct, and global self-worth (Harter, 2012a). Similar to the Pictorial Scale, each statement has a score range of 1–4 and each subscale contains 6 items, for a total score range of 36–144. The Self-Perception Profile for Children

is administered and scored in the same way as the pictorial scale, however, in lieu of picture books, the participant is read the questions while following along with the written survey. Internal consistency reliability for grade 3–6 children ranged from .76–.85 and exploratory and confirmatory factor analysis from .72–.90 (Harter, 2012a). As the above perception scales refer to either ‘physical’ (grade 2) or ‘athletic’ (grade 3 and 4) depending on the scale, this paper will refer to both as ‘perceptions of physical competence’.

Two separate measures were used to assess perceptions of physical competence as each measure is developmentally appropriate for the grade in which it was administered (Harter & Pike, 1984). Children in grade 2 are more responsive to a pictorial format as it aids with comprehension, engagement, and results in more meaningful responses (Harter & Pike, 1984). Additionally, the grade 2 measure depicts the skills and specific activities being assessed with more concrete language and images (e.g., “running fast”) compared with the grade 3 and 4 measure which uses more developmentally appropriate trait labels and general descriptions (e.g., “athletic”) (Harter & Pike, 1984).

Procedures

The project coordinator and lead investigator trained research assistants to administer both the TGMD-2 and perceptions questionnaires as per the assessment tool manuals (Harter, 2012a; Ulrich, 2000) at the beginning of each data collection year. The project coordinator and lead investigator were present at every data collection session to ensure the measurement tools were administered as per protocol.

Motor skill assessment was completed during physical education classes. All children participated during the data collection sessions, however, only those who consented to participate were video recorded (Sony Handycam HDR-CX240, Tokyo, Japan). The project coordinator divided the physical education classes into four groups of students, and established four testing stations in the school gymnasium. Children rotated through all four stations over two 30-minute physical education classes. In cases where physical education classes were one-hour duration only one data collection session occurred. After testing was completed, the digital video data was downloaded onto a secure server at the University of Victoria and scored by a researcher trained in scoring procedures consistent with the TGMD-2 manual (Ulrich, 2000).

Consented children completed the perceptions of competence questionnaire one-on-one with a trained administrator. Children were removed from the classroom and taken to a quiet location in the school where there was minimal noise and distraction (e.g., the library or an available multi-purpose room). Children were reminded that there were no right or wrong answers and to simply answer what they felt was true for them. After the administration of the first few questions, some children in grades 3 and 4 indicated a preference to read and complete the questionnaire independently. The administrator remained with the child to ensure correct completion of the questionnaire and answer any questions from the participant.

Data Treatment and Analysis

Descriptive statistics were calculated for participant age and sex, as well as both motor skill subscales (locomotor and object control) for grades 2, 3, and 4.

Descriptive statistics were also calculated for the relevant perceptions subscales (physical competence for grade 2 and athletic competence for grade 3 and 4). All data were checked for normality and were normally distributed. It should be noted that for motor skills data, only one participant achieved the maximum score on object control skills in grade 3 and grade 4 and the sample did not reach a ceiling effect on either subscale.

We established interobserver agreement (IOA) using the formula $\text{Number of Agreements} / (\text{Number of Agreements} + \text{Disagreements})$ (Thomas, Nelson, & Silverman, 2011), and reported these data as a percentage of agreement. Initially, the lead investigator (primary scorer) and a research assistant (reliability scorer) read and mastered the written descriptions of each skill component description. Next, these scorers practiced interpreting those descriptions with video of children's performances of each TGMD-2 skill. They then practiced scoring with pre-scored videos to exceed the criterion set for the project of a minimum of 80% agreement, and finally they scored the same videos independently. Again, the minimum acceptable standard was 80% agreement. IOA, computed on 10% of the participants, was 89% for grade 2, 89% for grade 3, and 84% for grade 4.

In order to determine an accuracy of perceptions of physical competence score; motor skills (locomotor and object control combined) and perceptions of physical competence raw scores for grades 2, 3, and 4 were converted into standardized z -scores (as per Weiss & Horn, 1990). Boys' and girls' z -scores were converted separately using raw motor skills and perceptions score means and standard deviations. Participants' motor skills z -scores were subtracted from perceived physical competence z -scores to determine an accuracy z -score. Following the data treatment procedures completed by Weiss and Horn (1990), participants were categorized into one of three groups based on their accuracy z -scores: underestimators (those who perceived their skills to be lower than the mid-range of the sample); average estimators (those where perceptions and motor skills scores were in the mid-range of the sample); and, overestimators (those who perceived their skills to be higher than the mid-range). Participants with z -scores in the lower quartile of the z -score frequency distribution were classified as underestimators, those in the middle 50% as average estimators, and finally, those in the upper quartile as overestimators (Weiss & Horn, 1990). Using these same frequency distribution z -score cut points, participants in the current study were categorized as either under, accurate, or overestimators of their physical competence.

Four repeated measures analyses of variance with Sex and accuracy group (Group) as factors were used to determine change over time in locomotor skills, object control skills, perceptions of physical competence, and accuracy of perceived physical competence. All data analysis was conducted using SPSS version 24 (IBM Corp., Armonk, NY).

Results

Descriptive statistics (organized by accuracy Group) for participants' motor skills (locomotor and object control), perceptions of physical competence (PPC), and accuracy scores are presented in Table 1. Average PPC scores across all grades and

Table 1 Descriptive Statistics and Repeated Measures ANOVA Post Hoc Comparisons for Motor Skills, Perceptions of Physical Competence, and Accuracy z-Scores for Boys and Girls by Group

Variable (Range)	Sex	Grade 2		Grade 3		Grade 4	
		M	SD	M	SD	M	SD
All participants							
Locomotor skills (0–48)	M ^{a,b,c}	29.8	5.1	31.2	5.2	32.9	4.4
	F ^{b,c}	32.2	4.3	32.4	4.4	33.5	4.6
Object control skills (0–48)	M ^{a,c}	32.4	5.9	35.9	6.1	35.6	6.0
	F ^{a,c}	27.6	5.8	29.1	5.1	28.9	5.7
PPC (6–24)	M	19.7	2.9	19.5	3.8	19.0	3.7
	F ^{a,c}	20.8	2.6	17.5	4.2	17.7	3.5
Accuracy z-scores (–3.41 to 4.37)	M	0.05	1.2	0.12	1.1	0.15	1.1
	F	0.03	1.3	–0.02	1.3	0.04	1.1
Underestimators							
Locomotor skills (0–48)	M ^b	32.0	4.2	31.5	4.9	33.0	4.2
	F ^a	34.1	3.9	32.3	5.1	33.0	4.9
Object control skills (0–48)	M	36.0	5.5	35.6	6.6	36.6	7.3
	F	31.3	5.6	29.9	6.1	31.0	6.4
PPC (6–24)	M ^c	17.3	2.8	18.6	4.2	19.2	3.5
	F	18.4	2.8	17.7	4.3	17.6	3.3
Accuracy z-scores (–3.41 to 4.37)	M ^{a,c}	–1.40	.40	–0.09	1.0	0.07	1.3
	F ^{a,c}	–1.60	.70	–0.06	1.1	–0.19	1.0
Average estimators							
Locomotor skills (0–48)	M ^{a,c}	30.7	4.8	32.2	5.1	32.9	4.8
	F ^{b,c}	32.9	3.3	32.7	4.2	34.0	4.3
Object control skills (0–48)	M ^{a,b,c}	32.7	5.3	37.9	5.6	36.2	5.3
	F ^a	27.8	5.2	29.1	5.2	28.3	4.9
PPC (6–24)	M ^b	20.0	2.6	19.9	3.3	19.2	3.7
	F ^{a,c}	21.0	2.3	17.4	4.1	17.9	3.6
Accuracy z-scores (–3.41 to 4.37)	M	0.01	.46	–0.05	.92	0.11	1.1
	F	<0.01	.45	–0.07	1.3	0.11	1.1
Overestimators							
Locomotor skills (0–48)	M ^{a,b,c}	25.9	4.4	29.0	5.3	32.5	3.8
	F ^{a,c}	28.9	4.8	32.1	4.0	33.1	4.4
Object control skills (0–48)	M ^{a,c}	28.2	4.8	32.3	5.2	33.5	5.4
	F ^{a,c}	23.6	4.4	28.2	3.7	27.9	6.1
PPC (6–24)	M ^{a,c}	21.6	1.8	19.4	4.4	18.6	3.9
	F ^{a,c}	22.8	1.5	17.4	4.4	17.5	3.7
Accuracy z-scores (–3.41 to 4.37)	M ^{a,c}	1.50	.53	0.65	1.3	0.32	1.1
	F ^{a,c}	1.70	.77	0.11	1.5	0.13	.97

Note. ^a Significant change from grade 2–3; ^b Significant change from grade 3–4; ^c Significant change from grade 2–4. Significant at $p < .05$. M = Male; F = Female; PPC = Perceptions of physical competence.

for both boys and girls were generally positive, ranging from a mean of 17.5–20.8. The range of mean PPC scores were slightly higher within the groups, with the overestimators having the highest and the underestimators having the lowest PPC scores. Contrastingly, the mean locomotor and object control raw scores reported in Table 1 for all participants across all grades were generally low. Using Ulrich's (2000) tables to convert raw scores into percentile ranks, the mean raw scores translate to percentile ranks ranging from 5–9. There was more variability of motor skill raw scores among the groups, see Table 1.

A repeated measures ANOVA revealed there were significant effect of Time on Locomotor skills, $F(2, 231) = 30.07, p < .001$, partial eta-squared (η_p^2) = .207. Contrasts revealed that locomotor skills were significantly higher in grade 3 compared to grade 2, $F(1, 232) = 8.31, p = .004$, $\eta_p^2 = .035$, and were significantly higher in grade 4 compared to grades 2 and 3, $F(1, 232) = 4.91, p = .008$, $\eta_p^2 = .041$. There was also a significant main effect for Sex on locomotor skill proficiency, $F(2, 231) = 8.31, p = .004$, $\eta_p^2 = .035$. Bonferroni post hoc comparisons revealed that the girls' locomotor skills were higher than the boys' in grade 2, but there were no significant sex-based differences in grades 3 or 4. Change over time for boys and girls is reported in Table 1. There was a significant interaction effect between Group and locomotor skill proficiency over time, $F(4, 462) = 12.61, p < .001$, $\eta_p^2 = .098$; see Table 1 for the post hoc comparisons of these differences. The interaction between Sex and Group on locomotor skill proficiency over time was not significant, $F(4, 462) = 2.26, p = .335$, $\eta_p^2 = .019$.

Similar to the pattern for locomotor skills, object control skills also improved significantly over time, $F(2, 231) = 33.76, p < .001$, $\eta_p^2 = .226$. Contrasts revealed that object control skills were significantly higher in grade 3 compared to grade 2, $F(1, 232) = 46.53, p < .001$, $\eta_p^2 = .167$, and were significantly higher in grade 4 compared to grades 2 and 3, $F(1, 232) = 12.57, p < .001$, $\eta_p^2 = .051$. There was also a significant main effect for Sex on object control skill proficiency, $F(2, 231) = 3.79, p = .024$, $\eta_p^2 = .032$. Bonferroni post hoc comparisons revealed that the boys' object control skills were significantly higher than the girls' in each grade. Change over time for boys and girls is reported in Table 1. There was a significant interaction effect between Group and object control skill proficiency over time, $F(4, 462) = 13.28, p < .001$, $\eta_p^2 = .103$, see Table 1 for the post hoc comparisons of these differences. The interaction between Sex and Group on object control skill proficiency over time was not significant, $F(4, 462) = 2.26, p = .051$, $\eta_p^2 = .020$.

Children's PPC scores decreased significantly over time, $F(2, 231) = 37.07, p < .001$, $\eta_p^2 = .243$. Contrasts revealed that PPC scores were significantly lower in grade 3 compared to grade 2, $F(1, 232) = 46.40, p < .001$, $\eta_p^2 = .167$, and were significantly lower in grade 4 compared to grades 2 and 3, $F(1, 232) = 22.43, p < .001$, $\eta_p^2 = .088$. There was also a significant main effect for Sex on object control skill proficiency, $F(2, 231) = 3.79, p = .024$, $\eta_p^2 = .032$. Using Bonferroni post hoc comparisons, the girls' PPC scores were significantly higher in grade 2, but significantly lower in grades 3 and 4, when compared to the boys' scores. Change over time for boys and girls is reported in Table 1. There was a significant interaction effect between Group and PPC scores over time, $F(4, 462) = 15.00, p < .001$, $\eta_p^2 = .115$; see Table 1 for the post hoc comparisons of these differences. The interaction between Sex and Group on PPC scores over time was not significant, $F(4, 462) = 0.99, p = .540$, $\eta_p^2 = .007$.

Figure 1 — Accuracy score trajectories for boys from grade 2 to grade 4.

Figure 2 — Accuracy score trajectories for girls from grade 2 to grade 4.

For the sample as a whole, accuracy did not change over time, $F(2, 231) = 0.22$, $p = .802$, $\eta_p^2 = .002$, nor was there a significant main effect of Sex on accuracy, $F(2, 231) = 0.63$, $p = .532$, $\eta_p^2 = .005$. There was, however, a significant interaction effect between Group and accuracy scores over time, $F(4, 462) = 50.54$, $p < .001$, $\eta_p^2 = .304$; see Table 1 for the post hoc comparisons of these differences. Changes in girls' and boys' accuracy from grade 2 to grade 4 for each group are displayed in Figures 1 and 2. The interaction effect between Sex and Group on accuracy over time was not significant, $F(4, 462) = 1.44$, $p = .219$, $\eta_p^2 = .012$.

Discussion

The aim of this study was to determine if the accuracy of perceptions of physical competence changed for boys and girls from grade 2 to grade 4. To inform potential

changes in accuracy it was important to first examine changes in motor skills and perceptions of physical competence across grades.

Developmental Changes in Motor Skills

It was expected that motor skills would improve from grade 2 to grade 4. Overall, locomotor and object control skills of all participants improved from grade 2–4. Specifically, boys' locomotor skills improved from grade 2–3 and grade 3–4 and girls' locomotor skills improved from grade 3–4. Object control skills improved significantly for all boys and girls from grade 2–3; however, there was no change for boys or girls in object control skills from grade 3–4, indicating that the object control skills plateaued in our sample at grade 3. Ideally, the majority of children should be able to demonstrate mature motor skill patterns by the end of middle childhood, approximately 7–8 years of age (Clark & Metcalfe, 2002; Haubenstricker & Seefeldt, 1986). These mature patterns can then be combined, developed, and applied to a variety of task and environmental contexts (e.g. an overhand throw becomes a pitch in baseball or an overhead smash in tennis). However, by grade 4, boys and girls scored 75% and 60% of the maximum possible object control skills score, respectively. Similarly, of the maximum possible locomotor skills score boys achieved 69% and girls achieved 70%. Like the findings from other parts of the world (Barnett et al., 2010; Spessato et al., 2013), many children in this study had not mastered their fundamental motor skills. This seemed particularly true for the girls' object control skills and further supports that boys consistently demonstrate higher object control scores than girls (Barnett et al., 2011; Barnett et al., 2008; Barnett et al., 2015; Crane, 2016; Field & Temple, 2017; Hardy, King, Farrell, Macniven, & Howlett, 2010; LeGear et al., 2012; Liong et al., 2015; Temple et al., 2016). It is important to note that the results presented in the current study are grade-related changes as opposed to age-related changes, and it should be taken into consideration that there can be up to 12 months of age variation in each grade.

Although the locomotor and object control skills of the participants in this study significantly improved, some of the raw score changes were minimal (e.g. girls' locomotor skills improved from 32.2 to 33.5 over the period of two years). While improvement is encouraging, these increases do not necessarily reflect meaningful improvement. The low motor skills scores in this study confirm the need to continue to focus on motor skills development through middle childhood. Stodden and colleagues (2008) discuss how the time from early to middle childhood is a period of vulnerability where children who have lower actual motor skill levels will also demonstrate lower perceived motor skill competence and are, ultimately, less physically active. The results of this study suggest that this period of vulnerability may extend further into middle childhood. It is unclear why the motor proficiency of the participants in this study is not improving in a meaningful way. However, as mastery of motor skills is a key element in the development of positive self-perceptions (Horn, 2004) and both motor skill proficiency (Barnett et al., 2011; Barnett, van Beurden, Morgan, Brooks, & Beard, 2009) and perceptions of physical competence (Babic et al., 2014) are predictors of participation in physical activity, it is essential that children are provided with opportunities to master these basic skills.

In this study, children were divided into three groups in grade 2 based on the extent to which their perceptions of physical competence and motor skill proficiency z-scores aligned. Initially, in grade 2, underestimators had the highest motor skills scores and overestimators the lowest. By grade 4, however, motor skills scores were comparable for all three groups. This convergence of motor skills scores was the result of the underestimators skills remaining stable across the grades, while the overestimators and average estimators skills improved. Underestimating boys and girls saw the least improvement in both locomotor and object control skills across the grades. This lack of improvement for the underestimators may be related to the findings of Weiss and Horn (1990) and theories posited by Stodden and colleagues (2008), which suggest that children who underestimate their physical abilities or have low perceptions of physical competence may be less likely to engage in physical activity. Without this engagement, these children are less likely to develop motor skills through regular practice.

In contrast, the overestimators, who began with the lowest locomotor and object control skill scores, improved both motor skill sub-tests. Experts have suggested that children with high perceptions may be more inclined to persist at tasks because they feel they are competent (Harter, 2012b; Horn, 2004; Stodden et al., 2008). High perceptions have also been found to be connected with higher motivation for physical education and physical activity participation in adolescents (De Meester et al., 2016). Task persistence may foster motor skill development as children spend more time engaging in activities that involve these skills. The average estimators did not exhibit a consistent pattern of motor skill improvement for either subscale. This is likely due to the larger sample size used in the average estimators' group.

Developmental Changes in Perceptions of Physical Competence

Experiencing a drop in perceptions of physical competence scores or having 'low' scores is not necessarily negative or reflective of poor self-confidence. It may, as we hypothesized would occur from grade 2 to grade 4, be a sign of more realistic self-perceptions. Although we hypothesized that perceptions of physical competence would decrease for both boys and girls from grade 2 to grade 4, this was only the case for girls. Overall, boys' perceptions of physical competence did not change from grade 2 to grade 4. In contrast, girls' perceptions of physical competence dropped significantly from grade 2 to grade 3 and remained stable from grade 3 to grade 4. This stability of perceptions from grade 3 to grade 4 is consistent with van Veen and colleagues (2019) finding that perceptions of motor competence remain fairly stable over a one-year period for boys and girls aged 8–9 years. In grade 2, the girls had significantly higher perceptions than the boys did, yet in grades 3 and 4, the girls' perceptions were significantly lower than the boys'. These sex-based differences in perceptions of physical competence are in keeping with findings that boys in middle childhood have higher perceptions of physical competence than girls (Barnett et al., 2015; Pesce et al., 2018; van Veen et al., 2019; Wigfield et al., 1997). The reason for these sex-based differences, however, is yet to be established and should be considered in future research.

Changes in Accuracy of Perceived Physical Competence

It was hypothesized that the accuracy of boys' and girls' perceptions of physical competence would increase from grade 2 to grade 4 as a result of an increase in motor skill proficiency and a decrease in perceptions of physical competence. This was not the case for the entire group or for boys and girls separately, over time. However, as shown in Figures 1 and 2, accuracy showed observable change over time when examined by group. It was clear that there was substantial variability in the accuracy of children's estimates in grade 2, but by grade 3, there was considerable convergence for both the boys and girls, with the exception of the boys who overestimate their ability. Those overestimating boys were also quite accurate in their perceptions of physical competence by grade 4.

A concerning trend in these findings was that the underestimating children (both boys and girls) had the highest object control and locomotor skills in grade 2, compared with the average and overestimating children. However, as Table 1 depicts, those boys and girls showed no development of their object control skill across the grades and negative change in locomotor skills among the girls from grade 2 to 3. The underestimating boys did show a significant increase in their perceptions of competence, from a very low 17 in grade 2 to 19 in grade 4, which was comparable to the average and overestimating boys. It seemed that the underestimating boys were becoming more cognizant of their actual skill level, but unfortunately, their skills were virtually stagnant from 7 to 9 years of age. The picture is even more troubling for the underestimating girls. There was no change in the girls' perceptions of their abilities, which were unrealistically low, and no or negative change in their skills. The lack of change in girls' perceptions suggests that the girls' somewhat negative perceptions of their physical competence was affecting, or being affected by, their lack of skill development. These findings are in keeping with competence motivation theory, which dictates that children are more or less likely to participate in activities dependent on their perceived competence (Harter, 1999, 2012b). The underestimating girls in this study perceive their object control and locomotor skills to be worse than they actually are, and this low perceived competence may reduce motivation to pursue activities where these skills are required. As a consequence, these girls may not improve their skills.

Under and overestimator boys and girls had significantly increased accuracy from grade 2 to grade 3, which then plateaued in grade 3. Only the participants who were considered to have an accuracy outside of the mid-range saw an improvement in accuracy, which provides further support to the literature that accuracy of perceptions of competence improves as children get older, and that by age 8 years (~ grade 3), children have a realistic sense of their abilities (Harter, 2012b). These results support the findings of Weiss and Horn (1990) who reported increases in accuracy over time, and may partly be explained by the expansion of feedback sources (and the ability to interpret feedback) for the participants as they progress through the elementary school years (e.g., new coaches, teachers, peers) which may have helped develop more accurate perceptions (Weiss, Ebbeck, & Horn, 1997). Additionally, the findings of the current study build on those of Weiss and Horn (1990) by using a direct measure of motor skills in order to determine an accuracy score, and provide evidence that some children do in fact have accurate perceptions at this age.

Future research should examine the extent to which actual motor skills and other variables, such as participation, instruction, or practice contribute to the development of perceptions of physical competence. A recent study by Pesce et al. (2018) found that both locomotor and object control skills contributed to only a small, yet significant, amount of variance (5 and 6%, respectively) in perceptions of competence among 7-year-old children. The authors attributed this to the children's immature self-evaluation skills. These immature self-evaluation skills were highlighted by the authors' finding that children who overestimated their abilities actually participated in more sports practice, which is consistent with theory suggesting that young children can equate effort (or in this case sports practice) with competence (Harter & Pike, 1984). Given that low motor skills levels are associated with low physical activity participation (Barnett et al., 2015; Crane et al., 2015), our findings suggest that there might be particular groups at risk of low participation, such as the underestimating girls, and an examination of accuracy as a predictor of physical activity participation is warranted. Further investigation into the relative contribution of type of skill, practice, instruction, and participation to the formation of perceptions of physical competence and perception accuracy is needed. Lastly, the current study used a non-aligned measure of perceptions of physical competence when determining accuracy while other authors have used an aligned instrument when assessing actual and perceived motor skills (Barnett, Vazou, et al., 2016; Estevan & Barnett, 2018). Further investigation into the impact of using both aligned and non-aligned measures would be a valuable contribution to this area of study.

Conclusion

Children in this study had less than ideal motor skill development over time which is alarming in itself, however a sizable proportion of them did demonstrate accurate and stable perceptions of physical competence from grade 2 to grade 4 (approximately 7–9 years of age). Moreover, for children who underestimated or overestimated their abilities in grade 2, there was significant change in the accuracy of their self-perceptions during their middle childhood (with some variations between boys and girls in terms of timing). The lack of motor skill development among the underestimating boys and girls from grade 2 to 4 is highly concerning. It is possible that these children's relatively negative views of their motor skill proficiency in some way led them to disengage from practicing skills or participating in activities that fostered motor development. On the other hand, children who overestimated their abilities in grade 2 did improve their motor skills across middle childhood. There is debate whether it is advantageous to emphasize and foster perceptions of motor competence in children beyond their actual skill level (Pesce et al., 2018). Our findings suggest that having higher self-perceptions than actual abilities or accurate self-perceptions in grade 2 was more beneficial for children than underestimating their abilities.

References

- Babic, M.J., Morgan, P.J., Plotnikoff, R.C., Lonsdale, C., White, R.L., & Lubans, D.R. (2014). Physical activity and physical self-concept in youth: systematic review and

- meta-analysis. *Sports Medicine Bulletin*, 44(11), 1589–1601. doi:[10.1007/s40279-014-0229-z](https://doi.org/10.1007/s40279-014-0229-z)
- Barnett, L.M., Lai, S.K., Veldman, S.L., Hardy, L.L., Cliff, D.P., Morgan, P.J., . . . Okely, A.D. (2016). Correlates of Gross Motor Competence in Children and Adolescents: A Systematic Review and Meta-Analysis. *Sports Med*, 46(11), 1663–1688. PubMed ID: [26894274](https://pubmed.ncbi.nlm.nih.gov/26894274/) doi:[10.1007/s40279-016-0495-z](https://doi.org/10.1007/s40279-016-0495-z)
- Barnett, L.M., Morgan, P.J., Van Beurden, E., Ball, K., & Lubans, D.R. (2011). A reverse pathway? Actual and perceived skill proficiency and physical activity. *Medicine and Science in Sports and Exercise*, 43(5), 898–904. PubMed ID: [20962694](https://pubmed.ncbi.nlm.nih.gov/20962694/) doi:[10.1249/MSS.0b013e3181fdffadd](https://doi.org/10.1249/MSS.0b013e3181fdffadd)
- Barnett, L.M., Morgan, P.J., van Beurden, E., & Beard, J.R. (2008). Perceived sports competence mediates the relationship between childhood motor skill proficiency and adolescent physical activity and fitness: a longitudinal assessment. *International Journal of Behavioral Nutrition and Physical Activity*, 5(1), 40. PubMed ID: [18687148](https://pubmed.ncbi.nlm.nih.gov/18687148/) doi:[10.1186/1479-5868-5-40](https://doi.org/10.1186/1479-5868-5-40)
- Barnett, L.M., Ridgers, N.D., & Salmon, J. (2015). Associations between young children's perceived and actual ball skill competence and physical activity. *Journal of Science and Medicine in Sport*, 18(2), 167–171. PubMed ID: [24685052](https://pubmed.ncbi.nlm.nih.gov/24685052/) doi:[10.1016/j.jsams.2014.03.001](https://doi.org/10.1016/j.jsams.2014.03.001)
- Barnett, L.M., van Beurden, E., Morgan, P.J., Brooks, L.O., & Beard, J.R. (2009). Childhood motor skill proficiency as a predictor of adolescent physical activity. *Journal of Adolescent Health*, 44(3), 252–259. PubMed ID: [19237111](https://pubmed.ncbi.nlm.nih.gov/19237111/) doi:[10.1016/j.jadohealth.2008.07.004](https://doi.org/10.1016/j.jadohealth.2008.07.004)
- Barnett, L.M., van Beurden, E., Morgan, P.J., Brooks, L.O., & Beard, J.R. (2010). Gender differences in motor skill proficiency from childhood to adolescence. *Research quarterly for exercise and sport*, 81(2), 162–170. PubMed ID: [20527301](https://pubmed.ncbi.nlm.nih.gov/20527301/).
- Barnett, L.M., Vazou, S., Abbott, G., Bowe, S.J., Robinson, L.E., Ridgers, N.D., & Salmon, J. (2016). Construct validity of the pictorial scale of Perceived Movement Skill Competence. *Psychology of Sport and Exercise*, 22, 294–302. doi:[10.1016/j.psychsport.2015.09.002](https://doi.org/10.1016/j.psychsport.2015.09.002)
- Clark, J.E., & Metcalfe, J.S. (2002). The mountain of motor development. *Motor Development: Research and Review*, 2, 163–190.
- Crane, J.R. (2016). *An examination of the relationships between fundamental motor skills, perceived physical competence, and physical activity levels during the primary years* (Doctor of Philosophy). University of Victoria, Victoria, British Columbia, Canada.
- Crane, J.R., Foley, J.T., Naylor, P.J., & Temple, V.A. (2017). Longitudinal change in the relationship between fundamental motor skills and perceived competence: Kindergarten to grade 2. *Sports*, 5(3), E59. doi:[10.3390/sports5030059](https://doi.org/10.3390/sports5030059)
- Crane, J.R., Naylor, P.J., Cook, R., & Temple, V.A. (2015). Do perceptions of competence mediate the relationship between fundamental motor skill proficiency and physical activity levels of children in kindergarten? *Journal of Physical Activity and Health*, 12(7), 954–961. PubMed ID: [25155099](https://pubmed.ncbi.nlm.nih.gov/25155099/) doi:[10.1123/jpah.2013-0398](https://doi.org/10.1123/jpah.2013-0398)
- De Meester, A., Maes, J., Stodden, D., Cardon, G., Goodway, J., Lenoir, M., & Haerens, L. (2016). Identifying profiles of actual and perceived motor competence among adolescents: associations with motivation, physical activity, and sports participation. *J Sports Sci*, 34(21), 2027–2037. PubMed ID: [26928601](https://pubmed.ncbi.nlm.nih.gov/26928601/) doi:[10.1080/02640414.2016.1149608](https://doi.org/10.1080/02640414.2016.1149608)
- D'Hondt, E., Deforche, B., Gentier, I., De Bourdeaudhuij, I., Vaeyens, R., Philippaerts, R., & Lenoir, M. (2013). A longitudinal analysis of gross motor coordination in overweight and obese children versus normal-weight peers. *International Journal of Obesity*, 37(1), 61–67. doi:[10.1038/ijo.2012.55](https://doi.org/10.1038/ijo.2012.55)
- Eccles, J.S. (1999). The development of children ages 6 to 14. *The Future of Children*, 9(2), 30–44. PubMed ID: [10646256](https://pubmed.ncbi.nlm.nih.gov/10646256/) doi:[10.2307/1602703](https://doi.org/10.2307/1602703)

- Estevan, I., & Barnett, L.M. (2018). Considerations Related to the Definition, Measurement and Analysis of Perceived Motor Competence. *Sports Med*, 48(12), 2685–2694. PubMed ID: 29938348 doi:10.1007/s40279-018-0940-2
- Farmer, O., Belton, S., & O'Brien, W. (2017). The relationship between actual fundamental motor skill proficiency, perceived motor skill confidence and competence, and physical activity in 8-12-year-old Irish female youth. *Sports*, 5(4), 74. doi:10.3390/sports5040074
- Field, S.C., & Temple, V.A. (2017). The relationship between fundamental motor skill proficiency and participation in organized sports and active recreation in middle childhood. *Sports*, 5(2), 43. doi:10.3390/sports5020043
- Hardy, L.L., King, L., Farrell, L., Macniven, R., & Howlett, S. (2010). Fundamental movement skills among Australian preschool children. *Journal of Science and Medicine in Sport*, 13(5), 503–508. PubMed ID: 19850520 doi:10.1016/j.jsams.2009.05.010
- Harter, S. (1982). The perceived competence scale for children. *Society for Research in Child Development*, 53(1), 10.
- Harter, S. (1999). *The construction of the self: A developmental perspective*. New York, NY: Guilford Press.
- Harter, S. (2012a). *Self-perception profile for children: Manual and questionnaires (grades 3 - 8) manual*. Denver, CO: Department of Psychology, University of Denver.
- Harter, S. (2012b). *The construction of the self: Developmental and sociocultural foundations* (2nd ed.). New York, NY: Guilford Press.
- Harter, S., & Pike, R. (1984). The pictorial scale of perceived competence and social acceptance for young children. *Child Development*, 55(6), 1969–1982. PubMed ID: 6525886 doi:10.2307/1129772
- Haubenstricker, J., & Seefeldt, V. (1986). Acquisition of motor skills during childhood. In V. Seefeldt (Ed.), *Physical activity and well-being* (pp. 41–102). Reston, VA: American Alliance for Health, Physical education, Recreation and Dance.
- Horn, T.S. (2004). Developmental perspectives on self-perceptions in children and adolescents. In M.R. Weiss (Ed.), *Developmental sport and exercise psychology: A lifespan perspective* (pp. 101–143). Morgantown, WV: Fitness Information Technology.
- Kershaw, P., Irwin, L., Trafford, K., & Hertzman, C. (2005). *The British Columbia atlas of child development* (1st ed.). Georgetown, ON: Human Early Learning Partnership.
- Kipp, L.E., & Weiss, M.R. (2013). Physical activity and self-perceptions among children and adolescents. In K.A. Martin Ginis (Ed.), *Routledge handbook of physical activity and mental health* (pp. 187–199). New York, NY: Routledge.
- LeGear, M., Greyling, L., Sloan, E., Bell, R.I., Williams, B.-L., Naylor, P.J., & Temple, V.A. (2012). A window of opportunity?: Motor skills and perceptions of competence in children in kindergarten. *International Journal of Behavioral Nutrition and Physical Activity*, 9(29), 5. doi:10.1186/1479-5868-9-29
- Liong, G.H., Ridgers, N.D., & Barnett, L.M. (2015). Associations between skill perceptions and young children's actual fundamental movement skills. *Perceptual and Motor Skills*, 120(2), 591–603. PubMed ID: 25706343 doi:10.2466/10.25.PMS.120v18x2
- Lopes, V.P., Saraiva, L., Gonçalves, C., & Rodrigues, L.P. (2018). Association between perceived and actual motor competence in Portuguese children. *Journal of Motor Learning and Development*, 6, S366–S377. doi:10.1123/jmld.2016-0059
- National Center for Education Statistics. (2018). Types of state and district requirements for kindergarten entrance and attendance, waivers and exemptions for kindergarten entrance, by state: 2018. Retrieved from https://nces.ed.gov/programs/statereform/tab5_3.asp
- Payne, G.V., & Isaacs, L.D. (2016). *Human motor development: a lifespan approach* (9th ed.). Scottsdale, AZ: Holcomb Hathaway.

- Pesce, C., Masci, I., Marchetti, R., Vannozzi, G., & Schmidt, M. (2018). When children's perceived and actual motor competence mismatch: Sport participation and gender differences. *Journal of Motor Learning and Development*, 6(2), S440–S460. doi: [10.1123/jmld.2016-0081](https://doi.org/10.1123/jmld.2016-0081)
- Robinson, L. (2011). The relationship between perceived physical competence and fundamental motor skills in preschool children. *Child Care Health and Development*, 37(4), 589–596. doi: [10.1111/j.1365-2214.2010.01187.x](https://doi.org/10.1111/j.1365-2214.2010.01187.x)
- Robinson, L., Stodden, D.F., Barnett, L.M., & Lopes, V.P. (2015). Motor competence and its effect on positive developmental trajectories of health. *Sports Medicine*, 45(9), 1273–1284. PubMed ID: 26201678 doi: [10.1007/s40279-015-0351-6](https://doi.org/10.1007/s40279-015-0351-6)
- Rudisill, M.E., Mahar, M.T., & Meaney, K.S. (1993). The relationship between children's perceived and actual motor competence. *Perceptual and Motor Skills*, 76(3), 895–906. PubMed ID: 8321605 doi: [10.2466/pms.1993.76.3.895](https://doi.org/10.2466/pms.1993.76.3.895)
- Spessato, B.C., Gabbard, C., Robinson, L., & Valentini, N.C. (2013). Body mass index, perceived and actual physical competence: the relationship among young children. *Child Care Health and Development*, 39(6), 845–850. doi: [10.1111/cch.12014](https://doi.org/10.1111/cch.12014)
- Statistics Canada. (2019). *Income highlights table, 2016*. Ottawa, ON: Government of Canada.
- Stodden, D.F., Goodway, J.D., Langendorfer, S.J., Robertson, M.A., Rudisill, M.E., Garcia, C., & Garcia, L.E. (2008). A developmental perspective on the role of motor skill competence in physical activity: An emergent relationship. *Quest*, 60(2), 290–306. doi: [10.1080/00336297.2008.10483582](https://doi.org/10.1080/00336297.2008.10483582)
- Temple, V.A., Crane, J.R., Brown, A., Williams, B., & Bell, R.I. (2016). Recreational activities and motor skills of children in kindergarten. *Physical Education and Sport Pedagogy*, 21(3), 268–280. doi: [10.1080/17408989.2014.924494](https://doi.org/10.1080/17408989.2014.924494)
- Temple, V.A., & Foley, J.T. (2017). A Peek at the Developmental Validity of the Test of Gross Motor Development-3. *Journal of Motor Learning and Development*, 5(1), 5–14. doi: [10.1123/jmld.2016-0005](https://doi.org/10.1123/jmld.2016-0005)
- Thomas, J.R., Nelson, J.K., & Silverman, S. (2011). *Research methods in physical activity* (6th ed.). Champaign, IL: Human Kinetics.
- Ulrich, D.A. (2000). *Test of gross motor development (TGMD-2)* (2nd ed.). Austin, TX: PRO-ED, Inc.
- van Veen, C., Schott, N., Lander, N., Tietjens, M., Hinkley, T., Dreiskämper, D., . . . Barnett, L.M. (2019). The Stability of Perceived Motor Competence of Primary School Children from Two Countries over One Year. *Measurement in Physical Education and Exercise Science*, 24(1), 74–80. doi: [10.1080/1091367X.2019.1675665](https://doi.org/10.1080/1091367X.2019.1675665)
- Weiss, M.R., & Ambrose, A.J. (2005). Children's self-perceptions in the physical domain: Between- and within-age variability in level, accuracy, and sources of perceived competence. *Journal of Sport and Exercise Psychology*, 27(2), 226–244. doi: [10.1123/jsep.27.2.226](https://doi.org/10.1123/jsep.27.2.226)
- Weiss, M.R., Ebbeck, V., & Horn, T.S. (1997). Children's self-perceptions and sources of physical competence information: A cluster analysis. *Journal of Sport and Exercise Psychology*, 19(1), 52–70. doi: [10.1123/jsep.19.1.52](https://doi.org/10.1123/jsep.19.1.52)
- Weiss, M.R., & Horn, T.S. (1990). The relationship between children's accuracy estimates of their physical competence and achievement-related characteristics. *Research Quarterly for Exercise and Sport*, 61(3), 250–258. doi: [10.1080/02701367.1990.10608687](https://doi.org/10.1080/02701367.1990.10608687)
- Westermeyer, J. (1989). Nontreatment factors affecting treatment outcome in substance abuse. *American Journal of Drug and Alcohol Abuse*, 15(1), 13–29. PubMed ID: 2646916 doi: [10.3109/00952998908993396](https://doi.org/10.3109/00952998908993396)
- Wigfield, A., Eccles, J.S., Kwang, S.Y., Harold, R.D., Arbretton, A.J.A., Freedman-Doan, C., & Blumenfeld, P.C. (1997). Change in children's competence beliefs and subjective

- task values across the elementary school years: A 3-year study. *Journal of Educational Psychology*, 89(3), 451–469. doi:[10.1037/0022-0663.89.3.451](https://doi.org/10.1037/0022-0663.89.3.451)
- Wrotniak, B.H., Epstein, L.H., Dorn, J.M., Jones, K.E., & Kondilis, V.A. (2006). The relationship between motor proficiency and physical activity in children. *Pediatrics*, 118(6), e1758–e1765. PubMed ID: [17142498](https://pubmed.ncbi.nlm.nih.gov/17142498/) doi:[10.1542/peds.2006-0742](https://doi.org/10.1542/peds.2006-0742)