

Relationships Between Product- and Process-Oriented Measures of Motor Competence and Perceived Competence

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Motor competence is associated with psychological and physical health outcomes. A reciprocal relationship between motor competence and perceptions of physical competence exists, but the developmental trajectory of the motor competence/perceived competence relationship is not well understood. Standardized assessments take a product- or process-oriented approach, but research concerning the motor competence/perceived competence relationship is limited to using process-oriented assessments. It is unknown whether boys and girls use product and process information differentially in the development of perceived competence. Children ($N = 411$) were aggregated into age groups. Perceived competence and product and process aspects of motor competence were assessed. Older children were more skillful than younger children but reported lower perceived competence. The motor competence/perceived competence association increased for both motor competence measures across age groups. Girls demonstrated stronger associations between process measures of motor competence and perceived competence, while boys indicated stronger associations between product measures of motor competence and perceived competence. When both motor competence measures were used to predict perceived competence, more variance in perceived competence was explained, compared with using independent predictors. The strength of the prediction increased across age groups, indicating that motor competence is a stronger predictor of perceived competence in older children.

Keywords: motor development, children, coordination, motor performance, pediatrics, perception

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Motor competence is associated with physical activity (Logan, Webster, Getchell, Pfeiffer, & Robinson, 2015), health-related fitness (Cattuzzo et al., 2016), and healthy weight status (Cattuzzo et al., 2016) in children and adolescents (Lubans, Morgan, Cliff, Barnett, & Okely, 2010). Although the development of motor competence may be a mechanism to promote positive developmental trajectories of health-related factors across childhood (Stodden et al., 2008), many children are unable to perform gross motor skills at developmentally appropriate levels (Cliff et al., 2012).

Perceived competence is an important contributor to motor competence in young children (Southall, Okely, & Steele, 2004; Stodden et al., 2008). Fox (1997) defines perceived competence as a subjective statement of personal ability. One domain-specific aspect of perceived competence is perceived *physical* competence, or an individual's perception of his/her movement capability (Fox & Corbin, 1989). Harter (1978) posited that individuals with high perceived competence are more likely to persist at activities such as sports and physically demanding pursuits than are individuals with low perceived competence. Thus, perceived competence is a critical construct relating to children's motor competence and health behaviors, as it is the most consistent predictor of physical activity among various aspects of self-concept (Babic et al., 2014).

The dynamic relationship between perceived competence and motor competence is complex from a developmental standpoint. A recent meta-analysis indicated that the strength of the perceived competence/physical activity association increases with age (Babic et al., 2014), but no such empirical evidence exists for perceived competence/motor competence relationships. While the development of perceived competence is certainly not limited to a child's ability to accurately assess his or her skillfulness, motor competence does appear to play a role in perceived competence throughout childhood. Cross-sectional research demonstrates that young children often have inflated perceptions of perceived competence in comparison with motor competence (Goodway & Rudisill, 1997; LeGear et al., 2012). These inflated perceptions are linked to limited cognitive capacity to accurately distinguish between motor competence and perceived competence (Harter & Pike, 1984; Harter, Stocker, & Robinson, 1999). Therefore, weak or nonsignificant correlations between motor competence and perceived competence are often seen in very young children (Lopes, Barnett, & Rodrigues, 2016). As children develop cognitively and transition from early to middle childhood, more accurate comparisons are made between their own skill and that of their peers. Thus, it is hypothesized that, in middle childhood, those with higher motor competence have higher perceived competence, and children with poor motor competence report lower levels of perceived competence (Morano, Colella, Robazza, Bortoli, & Capranica, 2011; Raudsepp & Liblik, 2002; Southall et al., 2004). Compared with children in early and middle childhood, those in late childhood are far less limited by their cognitive abilities when it comes to developing self-perceptions (Luna, Garver, Urban, Lazar, & Sweeney, 2004) and thus can more accurately assess their own motor competence. In late childhood and into adolescence, perceived competence plays a mediating role between motor competence and physical activity (Barnett, Morgan, van Beurden, & Beard, 2008), such that children who perceive themselves as poorly skilled (likely because they have low actual motor competence) tend to self-select out of physically demanding activities in which they are not motivated to participate (Stodden et al., 2008). To

date, no research exists confirming these hypotheses from a developmental perspective (Robinson et al., 2015), and the mediating role of perceived competence between motor competence and physical activity that has been confirmed in late childhood has yet to be examined in early and middle childhood.

Sex Differences in Perceived Physical Competence

Sex differences in perceived competence exist, but mechanisms that promote these differences are not well understood. Boys generally demonstrate higher perceived competence and motor competence regardless of age (Morano et al., 2011; Rudisill, Mahar, & Meaney, 1993). However, evidence suggests that there are no differences between the accuracy of boys' and girls' estimations of their motor competence (Goodway & Rudisill, 1997; Rudisill et al., 1993). Girls' lower perceived competence, coupled with low motor competence, may be an important factor relating to sex differences in physical activity and fitness levels in childhood, as girls generally display lower levels of physical activity and fitness across childhood (Ogden, Carroll, Kit, & Flegal, 2014; Trost et al., 2002). Though prepubescent boys and girls demonstrate similar physiological capabilities, girls often demonstrate different motor skill development progressions (McLeod, Reed, & Dienes, 2003). Literature robustly demonstrates sex differences in object control skill performance, favoring boys, but in locomotor skill performance, sex differences are not always clear (Barnett et al., 2016; Goodway, Robinson, & Crowe, 2010; Hardy, Reinten-Reynolds, Espinel, Zask, & Okely, 2012; Lopes, Rodrigues, Maia, & Malina, 2011).

Measurement of Motor Competence

Standardized motor competence assessments are either product or a process oriented. Process-oriented measures examine qualitative aspects (i.e., movement patterns) of movement. Product-oriented measures quantitatively assess outcomes of skill performance (e.g., speed, time to complete, number of hits). Research on associations between perceived competence and motor competence is limited to process-oriented motor competence assessments (Barnett, van Beurden, Morgan, Brooks, & Beard, 2009; Goodway & Rudisill, 1997; Morano et al., 2011; Rudisill et al., 1993). As the use of product-oriented motor competence assessments becomes more common in research addressing the relationship between motor competence and health-related variables (D'Hondt, Deforche, De Bourdeaudhuij, & Lenoir, 2009; Logan & Getchell, 2010; Lopes et al., 2011; Stodden, Langendorfer, & Robertson, 2009; Stodden, True, Langendorfer, & Gao, 2013), it is necessary to understand the relationship between perceived competence and product-oriented assessments of motor competence. That is, do children use information related to the outcome of skill performance as well as their understanding of their movement patterns to develop perceived competence? In addition, examining whether boys and girls differentially use product or process information in the development of perceived competence is important. The primary purpose of this study was to examine the association between children's perceived competence and process- and product-oriented skill assessments in early (4–5 years), middle (7–8 years), and late (10–11 years) childhood. A secondary purpose was to examine differences between

boys' and girls' perceived competence/motor competence relationships in terms of product and process measures of motor competence across the same age groups.

Method

Participants

Children from Ohio ($n = 194$) and Texas ($n = 217$) participated in the study (girls = 210, 51%). The sample consisted of three age groups of children from both geographical sites: 4–5 year-olds ($n = 139$), 7–8 year-olds ($n = 133$), and 10–11 year-olds ($n = 139$). The sample was evenly divided by race/ethnicity: white (33.6%), Hispanic (32.2%), and black (34.2%). Participants from Texas attended a rural public school; Ohio participants attended urban public schools (a Head Start preschool and a public elementary school). There were no significant differences among any of the dependent variables or demographic variables between the two sites.

Procedures

Institutional Review Board approval, parental consent, and child assent were obtained. Similar protocols for testing procedures were followed in Ohio and Texas. The Pictorial Scale of Perceived Competence and Social Acceptance (PSPCSA) and Self-Perception Profile for Children (SPPC) measures were administered one on one away from the classroom or gymnasium (e.g., a hallway or empty classroom). Children in both locations were videotaped performing all motor competence measures. There were two coders; one was responsible for coding the Texas videos and one responsible for coding the Ohio videos. Both coders received rigorous training from expert raters and had rated the Test of Gross Motor Development–2 (TGMD-2) before the current study. To determine interrater reliability, each coder coded an additional 15 randomly selected cases from the opposing site and compared cases with each other. Interrater reliability for the coding of the TGMD-2 was calculated at 89% across locations using the Percent Agreement Method (number of agreements/[number of agreements + disagreements] $\times 100$; Baumgartner, Strong, & Hensley, 2002). An intraclass correlation coefficient (ICC = .812, 95% CI = .61–.91, $F_{(29)} = 5.485$, $p < .000$) was calculated to demonstrate agreement between the coding of commonly coded location samples.

Measures of Motor Competence

The TGMD-2 (Ulrich, 2000) captured process-oriented aspects of motor competence. The TGMD-2 is a reliable ($r = .85$ – $.91$), norm-referenced, and widely used assessment of six locomotor skills (run, gallop, leap, hop, long jump, and slide) and six object control skills (throw, kick, catch, dribble, roll, and strike). Quantitative outcomes of five of the TGMD skills (kick, throw, standing long jump, hop, and run) were obtained as product scores of motor competence (Bürgi et al., 2011; Stodden, Gao, Goodway, & Langendorfer, 2014; Tveter & Holm, 2010). Children's movement patterns were coded on two videotaped trials of each skill following a researcher demonstration. Children were prompted to perform the skills of running, hopping, jumping, throwing, kicking, and striking with maximum effort as they

elicit the most advanced movement pattern and a maximum performance outcome (Langendorfer, Robertson, & Stodden, 2011).

TGMD-2 skills were scored from videotapes and evaluated on performance criteria established by Ulrich (2000). There are 3–5 performance criteria per skill with a score of 1 given if the child performed the criterion correctly, and a score of 0 if the criterion is not displayed. Criterion scores for two trials were added together to represent a “skill score” for each of the 12 skills. Skill scores for 12 skills were summed to obtain a total skill score.

The following measures were taken to analyze product scores of the five aforementioned skills. Throwing and kicking velocities were analyzed with a Stalker radar gun (Stalker Radar, Plano, TX); maximum speed was retained for analysis (Stodden et al., 2014). Running speed and hop stride length were calculated using video analysis software (Dartfish TeamPro 6, Alpharetta, GA). Maximum speed of four consecutive gait cycles (five foot contacts) for each direction was calculated and averaged for running speed. Maximum hop stride length for four consecutive hop cycles (heel-to-heel $\times$ 4) was calculated for each foot and normalized as a percent of standing height. Average hop distance using both feet was retained for analysis. Standing long jump distance was measured to the nearest centimeter and recorded live with a tape measure. The longest distance jumped, normalized to standing height, of the two trials used for the TGMD-2 assessment was used for analysis (Stodden et al., 2014).

Perceived Physical Competence

Children in the age range groups of 4–5 and 7–8 years completed the perceived physical competence subscale of the PSPCSA, which has an internal consistency of 0.86 and a reliability of 0.89 (Harter, 1985; Harter & Pike, 1984) with six items representing skills from the psychomotor domain (e.g., ability to run, skip, climb, tie shoelaces, and hop). Items, representative of a child’s sex and race, present two pictures side by side on each plate: a picture of a competent child and one of a noncompetent child. The child must first select the picture that is most representative of him/her, and then must indicate whether he/she is “just a little bit” like the child or a “a lot like” the child. Scores range from 1 to 4, where children indicating that they are “a lot like” the noncompetent child receive a score of 1, and children indicating they are “a lot like” the competent child receive a score of 4.

Children aged 10–11 years completed the perceived athletic competence subscale of the SPPC (Harter, 1982, 1985), which has high test–retest reliability (ICC = 0.90; Muris, Meesters, & Fijen, 2003) and an internal consistency of $\alpha = .45$ –0.79 (Harter, 1982, 1985; Muris et al., 2003). The SPPC includes six written statements about performing physical activity, sports, and games. Children were instructed to read the first statement and choose the phrase that most closely represented them; one phrase represented positive associations and one phrase represented negative associations (e.g., “Some kids do very well at all kinds of sports BUT other kids don’t feel that they are very good when it comes to sports.”). Children then indicated whether the chosen phrase was “sort of true” or “really true” for them. Scores range from 1 to 4, where children who indicated the non-skill-competent statement was really true for them receive 1 point, and children who indicated the skill-competent statement is really true for them receive 4 points.

Statistical Analyses

Descriptive statistics were calculated for all participants ($N = 411$). Means and standard deviations of raw TGMD-2 scores (total, object control, and locomotor), product scores, and perceived competence were calculated. A global product score was calculated to compare against the global (total) TGMD-2 score. To obtain a total product score, product scores were converted to z-scores and summed to create a product score index (Stodden et al., 2009; Stodden et al., 2013). Independent samples t tests examined age-specific sex differences of perceived competence, TGMD-2 raw scores, and the product score index. Pearson's bivariate correlations among perceived competence, product scores, and process scores (TGMD-2 total) were calculated by age group and sex. Two separate one-way ANOVAs determined differences in TGMD-2 raw scores and perceived competence across the three age groups. Linear regressions examined associations between motor competence and perceived competence across ages using product scores and TGMD-2 total raw scores separately as predictors. An additional regression with both the TGMD-2 total and product score as predictors examined the predictive utility of both measures on the perceived competence measure. All analyses were conducted using SPSS version 22 (2014 SPSS Inc., IBM Corp., Armonk, NY).

Results

Descriptive statistics are presented in Table 1. In all three age groups, t tests indicated boys demonstrated significantly higher product scores than did girls (4–5 year-olds: $F(1, 137) = 0.028, p < .001$; 7–8 year-olds: $F(1, 131) = 0.052, p < .001$; 10–11 year-olds: $F(1, 137) = 0.165, p < .001$). Independent t tests within age groups indicated that boys aged 10–11 years significantly outperformed girls on the TGMD-2 (total scores; $F(1, 137) = 8.001, p < .022$). No significant differences between boys' and girls' TGMD-2 total scores existed for the age range groups of 7–8 or 4–5 years. In all three age groups, boys demonstrated significantly higher TGMD-2 OC (object control) scores than did girls (4–5 year-olds: $F(1, 137) = 4.371, p < .001$; 7–8 year-olds: $F(1, 131) = 3.202, p < .001$; 10–11 year-olds: $F(1, 137) = 4.359, p < .001$). No significant sex differences existed within any age group for TGMD-2 LM (locomotor) scores or perceived competence.

TGMD-2 raw scores were statistically different across the three age groups, irrespective of sex, $F(2, 404) = 389.37, p < .001, \eta^2 = 0.66$. Tukey post hoc analysis revealed that the mean increase in TGMD-2 raw scores from the 4–5 year-old group ($M = 42.16, SD = 12.17$) to the 7–8 year-old group ($M = 62.39, SD = 10.14$) was statistically significant (20.23, 95% CI [17.14, 23.32], $p < .001$), as was the mean increase from the 7–8 year-old group to the 10–11 year-old group ($M = 78.37, SD = 9.92$; 15.98, 95% CI [12.88, 19.09], $p < .001$). These data indicate a skill progression across the three age groups, favoring the older groups. Perceived competence scores were statistically different across the three age groups, irrespective of sex, $F(2, 404) = 33.44, p < .001, \eta^2 = 0.14$. Tukey post hoc analysis determined a significant mean decrease in perceived competence score between the 4–5 year-old group ($M = 3.28, SD = 0.53$) and the 10–11 year-old group ($M = 2.90, SD = 0.63$;

Table 1 Means and Standard Deviations of Age, BMI, Motor Competence, and Perceived Competence Measures and Percentages of Ethnicity by Age Group and Sex

Characteristic	4–5 year olds			7–8 year olds			10–11 year olds		
	Girls (n = 68)	Boys (n = 71)	Total (n = 139)	Girls (n = 66)	Boys (n = 67)	Total (n = 133)	Girls (n = 76)	Boys (n = 63)	Total (n = 139)
Age	4.81 ± 0.54	4.86 ± 0.58	4.83 ± 0.56	8.21 ± 0.51	8.08 ± 0.61	8.16 ± 0.56	10.80 ± 0.55	10.61 ± 0.50	10.73 ± 0.54
Ethnicity									
White	30.9%	26.8%	28.8%	31.8%	32.8%	32.3%	42.1%	36.5%	39.6%
Hispanic	35.3%	28.2%	31.7%	37.9%	37.3%	37.6%	25.0%	30.2%	27.3%
Black	33.8%	45.1%	39.6%	30.3%	29.9%	30.1%	32.9%	33.3%	33.1%
Perceived competence	3.32 ± 0.49	3.24 ± 0.57	3.28 ± 0.53	3.45 ± 0.54	3.41 ± 0.38	3.43 ± 0.42	2.83 ± 0.62	2.97 ± 0.65	2.90 ± 0.63
TGMD-2 OC	15.04 ± 5.16	19.79 ± 7.39	17.47 ± 6.80**	27.11 ± 7.43	30.78 ± 5.57	28.93 ± 6.8**	36.33 ± 6.48	40.58 ± 4.51	38.26 ± 6.04**
TGMD-2 LM	25.78 ± 7.05	23.65 ± 8.33	24.7 ± 7.77	33.89 ± 6.63	33.02 ± 5.8	33.46 ± 6.22	39.44 ± 5.10	39.83 ± 4.64	39.62 ± 4.88
TGMD-2 total score	40.82 ± 10.51	43.44 ± 13.52	42.16 ± 12.17	61.00 ± 11.38	63.80 ± 11.38	62.39 ± 10.13	76.65 ± 10.92	80.45 ± 8.16	78.37 ± 9.91*
Product score index	-0.14 ± 0.47	0.13 ± 0.51	0.00 ± 0.51**	-0.31 ± 0.59	0.29 ± 0.58	0.00 ± 0.63**	-0.24 ± 0.62	0.29 ± 0.59	0.00 ± 0.66**

*Significant difference between boys and girls ($p < .05$).
**Significant difference between boys and girls ($p < .01$).

0.36, 95% CI [0.20, 0.50], $p < .001$), and between the 7–8 year-old group ($M = 3.43$, $SD = 0.42$) and the 10–11 year-old group (0.50, 95% CI [0.35, 0.65], $p < .001$). Group differences in perceived competence scores between the youngest age groups were not significant. These results indicate that perceived competence decreased with age.

Correlations between perceived competence/TGMD-2 scores and perceived competence/product scores aggregated by age group and sex are presented in Table 2. Correlation coefficients are interpreted according to Cohen's (1992) magnitude of effect sizes (small: $r = .10$; medium: $r = .30$; large: $r = .50$). A general examination of the perceived competence/motor competence association, irrespective of sex, indicated that the strength of the association increased for both product and process measures of motor competence across age group. Correlation coefficients from the TGMD-2/perceived competence association increased from a nonsignificant $r = .155$ in 4–5 year-olds to $r = .230$ ($p < .001$) in 7–8 year-olds to $r = .342$ ($p < .001$) in 10–11 year-olds. A similar trend existed for product scores and perceived competence across age group, with correlation coefficients strengthening from $r = .181$ ($p < .05$) in 4–5 year-olds to $r = .214$ ($p < .05$) in 7–8 year-olds to $r = .363$ ($p < .001$) in 10–11 year-olds.

When considering total motor competence scores (product score index and TGMD-2 total [process scores]), and with respect to sex differences and the perceived competence/motor competence relationship, girls generally demonstrated stronger associations between process measures of motor competence and perceived competence than did boys, and boys indicated stronger associations between product measures of motor competence and perceived competence than did girls (Table 2). In the 4–5 year-old group, a significant moderate correlation between product scores and perceived competence existed for boys ($r = .308$; $p < .01$), but not for girls. No significant correlations between TGMD-2 total scores and perceived competence were found in the 4–5 year-old groups for either sex. In the 7–8 year-old group, a moderate significant correlation between product scores and perceived competence existed for boys ($r = .368$; $p < .01$), but not for girls. A significant moderate correlation between TGMD-2 total scores and perceived competence existed for girls in the 7–8 year-old group ($r = .322$; $p < .01$), but not for boys. In the 10–11 year-old group, boys demonstrated a stronger (compared with the 7–8 group) correlation between product scores and perceived competence ($r = .458$; $p < .05$), and significant moderate correlations were found between product scores and perceived competence for girls ($r = .471$; $p < .01$). Significant moderate correlations between TGMD-2 total scores and perceived competence existed for girls ($r = .420$; $p < .01$) in this age group, but not for boys.

The series of regression analyses indicated that for each age group, when both process and product measures of motor competence were entered in the model as predictors, more variance in perceived competence was explained than when only one measure was used to predict perceived competence (Table 3). There was no evidence of multicollinearity for any of the multiple regression models, as assessed by variance inflation values (VIF) greater than 0.1 (4–5 year-old VIF = 1.33; 7–8 year-old VIF = 1.18; 10–11 year-old VIF = 1.56). Product and process scores were significant, although weak, independent predictors of perceived competence in each age group. In the 4–5 year-old models, when both measures were entered in the

Table 2 Associations Among Perceived Competence, Product Scores, and Process Scores by Sex and Age Group

Variables	4–5 year olds			7–8 year olds			10–11 year olds		
	Girls (<i>n</i> = 68)	Boys (<i>n</i> = 71)	Total (<i>n</i> = 139)	Girls (<i>n</i> = 66)	Boys (<i>n</i> = 67)	Total (<i>n</i> = 133)	Girls (<i>n</i> = 76)	Boys (<i>n</i> = 63)	Total (<i>n</i> = 139)
TGMD-2 total	.037	.231	.155	.322**	.067	.230**	.420**	.198	.342**
Product total	.078	.308**	.181*	.195	.368**	.214*	.471**	.458*	.363**

p* < .05; *p* < .01.

Table 3 Summary of Regression Analyses Using Product, Process, and Both Measures of Motor Competence to Predict Perceived Competence by Age

Model 1					Model 2					Model 3				
					4–5 year olds (n = 139)									
Predictors	β	SE_{β}	b	CI	β	SE_{β}	b	CI	β	SE_{β}	b	CI		
Product index	.181*	.088	.189	.015, .363	—	—	—	—	.081*	.100	.085	−.114, .283		
Process score ^a	—	—	—	—	.240**	.004	.010	.003, .018	.200*	.004	.009	−.000, .017		
R^2	.033				.058				.063					
7–8 year olds (n = 133)														
Predictors	β	SE_{β}	b	CI	β	SE_{β}	b	CI	β	SE_{β}	b	CI		
Product index	.214**	.054	.136	.028, .244	—	—	—	—	.165*	.059	.105	−.011, .222		
Process score ^a	—	—	—	—	.247**	.004	.010	.003, .017	.183*	.004	.008	.000, .015		
R^2	.046				.061				.084					
10–11 year olds (n = 139)														
Predictors	β	SE_{β}	b	CI	β	SE_{β}	b	CI	β	SE_{β}	b	CI		
Product index	.363**	.077	.350	.198, .501	—	—	—	—	.258**	.090	.247	.068, .425		
Process score ^a	—	—	—	—	.245**	.006	.016	.004, .028	.200**	.012	.025	.002, .049		
R^2	.132				.117				.163					

^aTGMD-2 raw total scores

* $p < .05$; ** $p < .01$.

model (Model 3), 6.3% of the variance in perceived competence was explained collectively by process and product scores of motor competence, $F(2, 136) = 4.542, p < .01$. In the 7–8 year-old models, product and process scores of motor competence both independently predicted perceived competence, but the variance explained in perceived competence nearly doubled (~5% vs. 8.5%) when both measures of motor competence were entered in the model $F(2, 137) = 5.819, p < .005$. In the 10–11 year-old models, product and process scores of motor competence were significant independent predictors of perceived competence, but the strength of the model increased when both measures of motor competence were used to predict perceived competence, $F(2, 134) = 13.066, p < .001$. The strength of the prediction in Model 3 increased across age groups, from $R^2 = .063$ in 4–5 year-olds, to $R^2 = .084$ in 7–8 year-olds, to $R^2 = .163$ in 10–11 year olds, indicating that motor competence is a stronger predictor of perceived competence in older children.

Discussion

The Perceived Competence/Motor Competence Relationship Across Age Bands

It is well understood that children's assessment of perceived competence is not stable over time. Very young children have difficulty discerning between effort expended and motor competence required to complete a task (Harter et al., 1999). Thus, correlations between motor competence and perceived competence in early childhood are weak and/or nonsignificant (Lopes et al., 2016), as they were in our sample. The absence of a significant relationship may seem like an undesirable finding. However, we contend that overinflated perceived competence motivates children to persist at skill acquisition and physical activities when effort is perceived as success (Stodden et al., 2008).

For 7–8 year-olds, slightly stronger relationships were found for both measures of motor competence and perceived competence. This finding supports that, as children get older, they begin to dissociate between effort and competence. That is, children in this age group have developed the requisite cognitive flexibility to comprehend that trying hard at a task is not equivalent to being good at a task (Anderson, 2002). Thus, in middle childhood, perceived competence becomes more closely aligned with motor competence. The motor competence/perceived competence relationship was strongest for the 10–11 year-olds despite this age group reporting lower perceived competence scores, compared with the other age bands. It is likely that 10–11 year-old children are more capable of accurately estimating their motor competence. Therefore, it was not surprising to see moderate associations between both process and product measures of motor competence with perceived competence in the oldest age group.

Product- and Process-Oriented Measures of Motor Competence and the Perceived Competence/Motor Competence Relationship

Regression models indicated that the variance in perceived competence explained by motor competence was higher when both product and process measures were

used as predictors. This is particularly important because studies examining the perceived competence/motor competence relationship primarily use process measures to predict perceived competence. The perceived competence/motor competence relationship could be better understood if more robust perspectives of motor competence were measured. A potential explanation for the increased variance is that children used the product-oriented feedback (e.g., speed and distance information) to provide additional relevant information about their perceived skill. Visual integration is necessary for children to develop perception (Harter & Pike, 1984); that is, children cannot see process-oriented movements (e.g., “Did I follow through when I threw the ball?”) as easily as they can product-oriented information such as distance jumped or speed of a throw. Thus, a general perception of how children feel about their movement and how they actually perform may provide unique variance in their overall perception of their competence. Regression analyses also indicated that the strength of associations increased across the three age bands such that the strongest model was seen in the 10–11 year-old age band. Overall, these results confirm Stodden and colleagues’ (2008) hypothesis that children’s perceived competence becomes more closely aligned with motor competence across childhood. As children develop a more sophisticated capability to compare themselves to their peers, which is based on cognitive development as well as having more experiences in skill development and peer comparisons, it seems logical that the alignment of perceptions with actual skill would increase over time.

Sex Differences in the Perceived Competence/Motor Competence Relationship

In all three age bands, significant associations between product-oriented measures of motor competence and perceived competence, but not between process-oriented motor competence and perceived competence, were found for boys. While girls demonstrated significant associations between product scores and perceived competence in the 10–11 year-old age group, their perceptions of skill appear more in line with process-oriented measures than with product scores. Additional research is needed to confirm the mechanisms by which boys and girls differentially perceive their physical skill.

Boys and girls demonstrated differences in perceived competence/motor competence relationships with respect to product and process aspects of motor competence. However, sex differences in motor competence were primarily associated with product scores (Table 1). Boys significantly outscored girls on the product score index across three age bands, but the only sex differences of process scores favored the boys in the 10–11 year-old age band. With respect to sex differences in process-oriented scores of motor competence, our findings contradict several other studies examining sex differences in early and middle childhood. Robinson (2011) and Goodway and Rudisill (1997) found that 4–5 year-old boys outscored girls on a process test of motor competence, and Okely and Booth (2004) found that boys aged 7.2–8.2 routinely outperformed girls on a process assessment of skill. Given that boys outscored girls in each age band on product assessment of skill, we suggest that discrepancies may exist between the TGMD-2 and our product assessment. The TGMD-2 may not be sufficiently sensitive and discriminatory to reveal sex differences in overall skill performance.

With respect to sex discrepancies in perceived competence, only one other study failed to find sex differences in reports of perceived competence, and this was among 4–5 year-olds (Goodway & Rudisill, 1997). Several other studies report differences in boys' and girls' perceived competence, all of which favor boys (McCullough, Muldoon, & Dempster, 2009; Robinson, 2011; Rudisill et al., 1993). As boys and girls may align their perceived competence differentially with different motor competence assessments, it is important to measure both aspects of motor competence to more accurately assess the relationship between motor competence and perceived competence. In addition, as associations tend to increase in strength across age, assessing both product and process motor competence data seems to be necessary for assessing the impact of motor competence and perceived competence on physical activity levels and other health-related variables.

This study is not without limitations. Two different measures were used to assess perceived competence among the various age groups. The PSPCSA and the SPPC, while valid, are global measures of perceived competence and do not directly address the actual skills tested in this study. Using pictorial or video scales of the actual movements being tested may provide a more accurate representation of the perceived competence/motor competence relationship (McGrane, Belton, Powell, Woods, & Issartel, 2016). For example, after the current study was completed, Barnett, Ridgers, Zask, and Salmon (2015) modified the existing perceived competence subscale of the PSPCSA to reflect the object control and locomotor skills from the TGMD-2. Future research should use such a measure when making comparisons of perceived competence to TGMD-2 scores. Finally, we examined developmental trajectories of the perceived competence/motor competence relationship from correlational data, and longitudinal data are necessary to confirm the results of this study.

Conclusion

There is a need to understand which factors positively influence the development of motor competence at given points in childhood. This study is unique in that we examined differences between perceived competence and motor competence across three distinct childhood age groups. Our results indirectly support the Stodden et al. (2008) model hypotheses, which suggest that associations between motor competence and perceived competence will strengthen across developmental time. This study is the first to examine differences in the accuracy of perceived competence based on product- and process-oriented measures of motor competence. Results suggest that assessing both product- and process-oriented motor competence is necessary as boys and girls may differ in what information they use to assess their motor competence level.

Interventions that aim to improve motor competence via planned instructional movement curricula have proven more successful at improving motor competence than simply allowing children free play time (Logan, Robinson, Wilson, & Lucas, 2012). Given the established relationship between motor competence and perceived competence, context-specific interventions that promote motor competence will likely impact perceived competence. Demonstrating high perceived competence is increasingly important because both motor competence and perceived competence

are associated with increased participation in physically demanding activities at all points in childhood and into adolescence (Babic et al., 2014; Cattuzzo et al., 2016; Logan et al., 2015). These results also suggest that future interventions that promote motor competence may benefit from emphasizing process-oriented aspects and outcomes of skill development for girls, and product-oriented aspects and outcomes of skill for boys. Finally, as children with low perceived competence tend to self-select out of physical activity (Weiss & Amorose, 2005), practitioners and parents should positively encourage children in their motor skill endeavors to promote continued development of positive perceived competence.

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