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Article

Actual vs. Perceived Motor Competence in Children (8–10 Years): An Issue of Non-Veridicality

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Abstract: The purpose of this study was to investigate the between- and within-sex differences in actual and perceived locomotor and object control skills in children (8–10 year). All participants (58 children (29 boys; 9.5 ± 0.6 years; 1.44 ± 0.09 m; 39.6 ± 9.5 kg; body mass index; 18.8 ± 3.1 kg·m^2)) completed the Test of Gross Motor Development (2nd edition) and the Pictorial Scale of Perceived Movement Skill Competence for Young Children. Between- and within-sex differences were assessed using independent and paired samples *t*-tests, respectively. For all tests, effect sizes and Bayes factors were calculated. There were significant differences ($p < 0.001$) between sexes for perceived locomotor and perceived object control skills (boys > girls), with Bayes factors extremely in favour of the alternate hypothesis ($_{BF}$: 55,344 and 460, respectively). A significant difference ($p < 0.001$) was found between girls' actual and perceived locomotor skills ($d = -0.88$; 95% confidence interval: −0.46 to −1.34), with Bayes factors extremely in favour of the alternate hypothesis ($_{BF}$: 483). A significant difference ($p < 0.001$) was found between boys' actual and perceived object control skills ($d = 0.69$; 95% CI: 0.2 to 1.12), with Bayes factors very strongly in favour of the alternate hypothesis ($_{BF}$: 41). These findings suggest that there exists an issue of non-veridicality between actual and perceived motor competence skills, and their subsets, and a sex-mediated discord in children (8–10 years).

Keywords: motor competence; actual; perceived; children; locomotor; object control

1. Introduction

A substantial literature base now affirms the association between children's motor competence (MC) and physical activity (PA) behaviours, potentially, to combat the global obesity epidemic [1–4]. Motor competence refers to a child's ability to perform a wide range of motor skills in a proficient manner [5]. During early childhood, motor competence is frequently defined as proficiency in the performance of fundamental motor skills (FMS) [3,6]. Fundamental motor skills are considered to be the basic building blocks to more advanced movement patterns [7], and generally consist of locomotor and object control skills. Locomotor skills necessitate moving the body from one position to another (i.e., running, leaping, jumping, and galloping) while object control skills either refer to the receiving or propulsion of an object with the hand or foot (i.e., throwing, kicking, striking, and catching) [8].

Despite the mounting evidence for the benefit of qualifying contextual MC or movement quality data, there remains an over-predominance in focusing on the quantity of activity, rather than the quality [9,10]. Only recently has there been a trend towards a joint consideration of exercise quantity and quality [9–14]. A pivotal meta-analysis highlighted that PA interventions dedicated to improving quantity of PA report little effect [15]. More recently, Adab et al. [16] reported in a longitudinal study that a one-year school/community-based PA intervention had no effect on body mass index (BMI) z-scores at 15- or 30-months post-intervention, highlighting that communities and schools are unlikely to impact on the childhood obesity epidemic by incorporating only PA targeted interventions.

Given the above evidence, it is clear that the approach to PA promotion in youths must move beyond the mere use of caloric expenditure as the primary measure of exercise intensity. This notion has been largely influenced by the agglomerative evidence on the complex and dynamic interrelationships between weight status, health-related fitness, and motor and cognitive development through childhood and beyond [3,17–20]. Further, motor skill competence (i.e., the qualitative proficiency in performing an array of skills requiring motor coordination and control) has been highlighted for its positive associations with PA levels and health benefits in children and adolescents [21].

Stodden et al. [6] developed a comprehensive conceptual model that asserts that childhood MC is a determinant of health. Concomitantly, Barnett et al. [22] demonstrated, albeit prospectively, that childhood MC has a fundamental role for long-term PA compliance and is predictive of health-related fitness later in life. These pivotal works have prompted a new line of developmental research that, by means of cross-sectional, longitudinal, and experimental evidence [23], have confirmed the inveterate nature of the Stodden et al. [6] conceptual model. Interestingly, children's perception of being competent, and not MC per se, matters for promoting and adhering to an active lifestyle, which is necessary for positive trajectories of health and well-being [24]. Longitudinal research has identified perceived MC as a mechanism through which motor skill proficiency in childhood contributes to a physically active and healthy lifestyle in adolescence [25–28]. Given the influence that both actual and perceived MC in childhood can have as health determinants, empirical research has focused on furthering our understanding of their dynamic and changing relationship throughout childhood and adolescence [6,29].

Masci et al. [30] highlight that children and adolescents with different MC-based profiles also differ in motivation to practice PA, and actual PA levels. Furthermore, perceived, more than actual competence, appears to determine motivation for PA participation in children [31]. In the studies of Bardid et al. [31] and De Meester et al. [32], primary school children with a higher perception of MC resulted in higher motivation with this motivation remaining even when a low level of actual motor proficiency was combined with high self-perception (i.e., overestimation). Commonality exists between the aforementioned studies in the form of (non) veridicality of the physical self-concept, defined as the relation between the subjective perception and the corresponding external validity criterion. However, this issue remains relatively unexplored [33].

A general axiom is that boys tend to be more physically active than their female counterparts [34,35], and generally display better object control skills than girls, however, evidence on sex differences in locomotor skills is equivocal [36,37]. Contentiously, many studies show that girls outperform boys in locomotor skills [26,38,39], whilst a comparable number of studies assert that boys have equal [40,41] or higher locomotor skill competence [42]. Concerning the perception of MC, sex differences seem to proliferate during child development [29,43,44]. Whilst some studies report that boys and girls around the pre-school years display equal perceptions of competence, from primary school years onward, higher self-perceptions in boys are consistently found [29,45–47]. Notwithstanding, differences between actual and perceived MC in young children are widespread, yet equivocal; as is the discord between sexes, which remains contentious and relatively unexplored. Therefore, the purpose of this study was to investigate the between- and within-sex differences in actual and perceived locomotor and object control skills in children (8–10 years).

2. Materials and Methods

2.1. Participants and Settings

A sample of 58 children (29 boys) (mean ± standard deviation: 9.5 ± 0.6 years, 1.44 ± 0.09 m, 39.6 ± 9.5 kg, body mass index: 18.8 ± 3.1 kg·m^2) from a primary school in the United Kingdom volunteered to take part in this study. Optimal sample size was calculated based upon the ability to detect a smallest unit change (raw score) of 0.5% and a generous between subject standard deviation of 2.0 (α = 0.05, power 0.95). This subsequently yielded a sample-size estimation of 57. To equalize the ratio of males to females, 58 participants were recruited and divided into two groups (29 males, 29 females). Prior to the research commencing, parental or legal guardian informed consent and child assent was attained. The study was conducted in agreement with the guidelines and policies of the institutional ethics committee, and in accordance with the Declaration of Helsinki (ETHICS201617, 14 December 2016).

2.2. Instruments and Procedures

Actual motor competence. Children's actual MC was measured using the Test of Gross Motor Development (2nd edition) (TGMD-2) [48]. The TGMD-2 includes 12 fundamental movement skills (six locomotor skills and six object control skills) and takes approximately 20 min to administer. The locomotor subtest consists of running, galloping, hopping, leaping, horizontal jumping, and sliding. The object control subtest contains striking a stationary ball, a stationary dribble, catching, kicking, overhand throwing, and underhand rolling. Following a visual demonstration, participants were asked to perform each skill twice. The TGMD-2 is a qualitative measure in which each skill is scored against performance criteria prescribed in an accompanying manual (three to five criteria per skill); the criteria were scored 1 (present) or 0 (absent). Ratings in each item were summed to compute scores for locomotor and object control skills (each score ranging from 0 to 48). The psychometric properties of the TGMD-2 have been evaluated and the manual reports excellent test-retest reliability and inter-rater reliability ($r > 0.85$) as well as a good internal consistency (Cronbach's α = 0.85 and 0.88 for locomotor and object control subtests, respectively). Construct, content, and concurrent validity have also been determined for children aged 3 to 10 years [48–50]. Two experienced assessors scored the TGMD-2, with excellent inter-rater reliability (ICC: 0.99).

Perceived Motor Competence. Children's perceived MC was assessed via The Pictorial Scale of Perceived Movement Skill Competence for Young Children (PSPMSC) [51] for the same locomotor and object control skills as the TGMD-2. The perceived MC assessment took approximately 10 min to administer. For each skill, children were shown two sex-specific illustrations of a child performing the skill in competent and less-competent ways. Children were asked which depiction they identified themselves with the most, with each question having the same standard structure: "This child is pretty good at X, this child is not that good at X: Which child is most like you?". Once children selected a picture, they were then asked to further indicate their perceived MC as more or less identifying with the selected picture. For the picture of the most competent child, the follow-up question was: "Are you pretty good or really good at X?", for the picture of the less competent child, the accompanying question was: "Are you sort of good or not that good at X?"; each item was scored 1 (not that good), 2 (sort of good), 3 (pretty good), or 4 (really good). Scores for locomotor and object control skills were summed to compute scores for locomotor and object control skills (each score ranging from 6 to 24). The PSPMSC has been shown to have acceptable face validity as well good test-retest reliability ($r > 0.78$) and internal consistency (Cronbach's α = 0.60–0.81; Barnett et al. [51]). Construct validity has also been established in children aged 4 to 10 years [48–50,52].

2.3. Data Analysis

Raw scores for the TGMD-2 and The PSPMSC were transformed into percentiles to facilitate statistical analyses, per manual guidelines [48]. Data were initially assessed for normality using a Shapiro-Wilk test, and found to be normally distributed ($p > 0.05$). Subsequently, between-sex differences for actual locomotor, actual object control, perceived locomotor, and perceived object control percentiles were assessed using independent samples *t*-tests. Within-sex differences for actual vs. perceived locomotor and object control percentiles were assessed using paired samples *t*-tests. Bayesian statistical analyses were conducted for within- and between-sex differences utilizing default priors [53–55], where Bayes factors expressing the probability of the data given $_{H10}$ (alternate hypothesis) relative to $_{H01}$ (null hypothesis; i.e., values larger than 1 are in favour of $_{H1}$) assuming that $_{H01}$ and $_{H10}$ are equally likely, were produced. Data were reported as mean ± SD, with effect sizes (Cohen's *d*, classified as: small (0.2), medium (0.5), large (0.8), or very large (1.3) [56] and 95% confidence intervals (CIs)). The alpha level was set at 0.05 a priori. Bayes factors were reported as the probability of the data given the alternate, relative to the null hypothesis, or vice-versa (classified as: anecdotal ($_{BF}$1–3), moderate ($_{BF}$3–10), strong ($_{BF}$10–30), very strong ($_{BF}$30–100), or extreme ($_{BF} > 100$)) [53–55]. All data analyses were conducted using the JASP statistical package (JASP Team, 2018, jasp-stats.org; version 0.8.6, University of Amsterdam, Amsterdam, The Netherlands).

3. Results

3.1. Between-Sex Differences

There was no significant difference ($p = 0.15$) found between sexes for actual locomotor skills (Female (F): 69.8 ± 5.27 vs. Male (M): 72.3 ± 7.47%; $d = 0.38$, 95% CI: 0.14 to 0.9) (Figure 1). Bayes factors found anecdotal evidence in favour of the null vs. alternate hypothesis ($_{BF}$: 1.5, i.e., null 1.5 times more probable than the alternate).

There was no significant difference ($p = 0.87$) found between sexes for actual object control skills (F: 62.75 ± 10.5 vs. M: 63.3 ± 15.2%; $d = 0.04$, 95% CI: −0.56 to 0.47) (Figure 1). Bayes factors found moderate evidence in favour of the null vs. alternate hypothesis ($_{BF}$: 3.72, i.e., null 3.72 times more probable than the alternate).

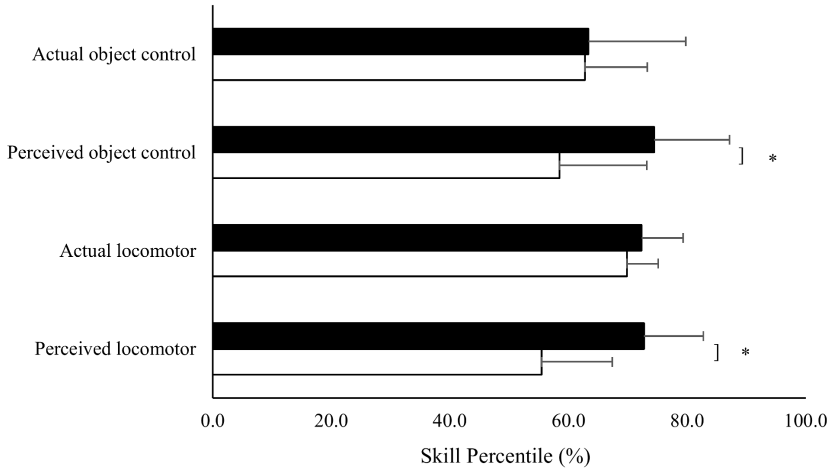

Figure 1. Between-sex perceived and actual locomotor and object control skill percentile scores. Black bars denote boys; white bars denote girls; * denotes significant difference between sexes ($p < 0.05$).

There was a significant difference ($p < 0.001$) found between sexes for perceived locomotor skills (F: 55.46 ± 11.8 vs. M: 72.7 ± 10.2%; $d = 1.6$, 95% CI: 0.95 to 2.14) (Figure 1). Bayes factors found extreme evidence in favour of the alternative vs. null hypothesis ($_{BF}$: 55,344, i.e., alternate 55,244 times more probable than the null).

There was a significant difference ($p < 0.001$) found between sexes for perceived object control skills (F: 58.5 ± 14.7 vs. M: 74.4 ± 12.6%; $d = 1.17$, 95% CI: 0.6 to 1.71) (Figure 1). Bayes factors found extreme evidence in favour of the alternate vs. null hypothesis ($_{BF}$: 460, i.e., alternate 460 times more probable than the null).

3.2. Within-Sex Differences

There was a significant difference ($p < 0.001$) found between girls' actual and perceived locomotor skills (Actual 69.8 ± 5.2 vs. Perceived 55.5 ± 11.9%; $d = -0.88$, 95% CI: −0.46 to −1.34) (Figure 2). Bayes factors found extreme evidence in favour of the alternative vs. null hypothesis ($_{BF}$: 483, i.e., alternate 483 times more probable than the null).

There was no significant difference ($p = 0.06$) found between girls' actual and perceived object control skills (Actual 62.8 ± 10.5 vs. Perceived 58.4 ± 14.7%; $d = -0.36$, 95% CI: −0.02 to −0.74) (Figure 2). Bayes factors found anecdotal evidence in favour of the null vs. alternate hypothesis ($_{BF}$: 1.01, i.e., null 1.01 times more probable than the alternate).

There was no significant difference ($p = 0.84$) found between boys' actual and perceived locomotor skills (Actual 72.3 ± 7.5 vs. Perceived 72.7 ± 10.2%; $d = 0.04$, 95% CI: −0.41 to 0.33) (Figure 2). Bayes factors found moderate evidence in favour of the null vs. alternate hypothesis ($_{BF}$: 4.97, i.e., null 4.97 times more probable than the alternate).

There was a significant difference ($p < 0.001$) between boys' actual and perceived object control skills (Actual 63.3 ± 16.2 vs. Perceived 74.4 ± 10.2%; $d = 0.69$, 95% CI: 0.2 to 1.12) (Figure 2). Bayes factors found very strong evidence in favour of the alternative vs. null hypothesis ($_{BF}$: 41, i.e., alternate 41 times more probable than the null).

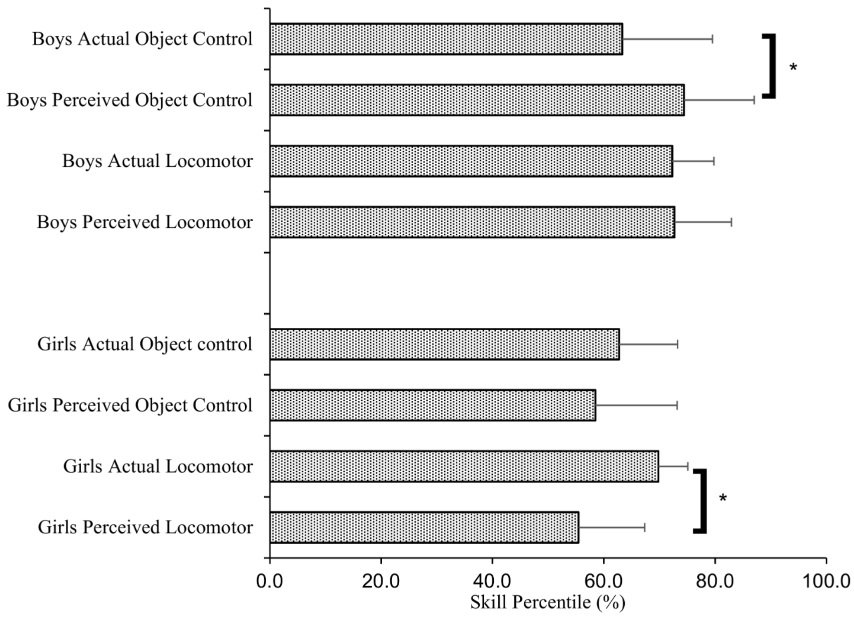

Figure 2. Within-sex differences for perceived and actual locomotor and object control skill percentile scores. * denotes significant difference between actual and perceived scores ($p < 0.05$).

4. Discussion

The purpose of this study was to investigate the between- and within-sex differences in actual and perceived locomotor and object control skills in children (8–10 years). In accord with the aforementioned purpose, the key findings of this study were:

(1) Boys perceived their locomotor and object control skills to be greater than girls.
(2) Girls perceived their locomotor skills to be lower than their actual locomotor skills.
(3) Boys perceived their object control skills to be greater than their actual object control skills.

4.1. Between-Sex Differences

Evidence on sex differences in locomotor skills is equivocal [26,36,37,57]. Contentiously, many studies show that girls outperform boys in their locomotor skills [26,38,39], whilst almost an equal number of studies assert that boys have equal [40,41] or higher locomotor skill competence [42]. It is, therefore, unsurprising that the findings of the present study should be equally equivocal for actual MC (locomotor and object control). There was no significant difference ($p = 0.15$) between boys and girls for actual locomotor skills (Figure 1), highlighting very little discord in actual locomotor skills between sexes. Furthermore, Bayes factors indicated that there was only anecdotal evidence to separate the null and alternate hypotheses. Similarly, there was no significant difference ($p = 0.87$) between sexes for actual object control skills (Figure 1), further supporting the observations of Bardid et al. [31] and Slykerman et al. [41].

There was a significant difference ($p < 0.001$) found between sexes for perceived locomotor skills, where boys perceived themselves to be ~20 percentage points higher than girls (Figure 1). This is supported by Bayes factors analysis, which found extreme evidence in favour of the alternative vs. null hypothesis ($_{\mathrm{BF}}$: 55,344). Similarly, boys also perceived their object control skills to be greater than that of the girls, with a significant difference ($p < 0.001$) found between sexes (Figure 1). Bayes factors found 'extreme' evidence in favour of there being a difference between sexes ($_{\mathrm{BF}}$: 460). Whilst the present study highlights differences in perceived, but not in actual, object control and locomotor skills, Brian et al. [58] concluded that there was relatively little sex-related discord for perceived and actual locomotor skills, however, there were evident differences for perceived and actual object control skills. This difference is likely influenced by age, with Brian et al. [58] assessing 4- to 5-year-olds, contrasting with the 8- to 10-year-olds in the present study. Concerning the perception of MC, sex-mediated differences are found to proliferate during child development [43,44]. The modal finding in the literature is that boys and girls around the pre-school years display equal perceptions of competence [59,60]. However, from primary school years onward, higher self-perceptions in boys are consistently found [45,46], which supports the findings in the present study.

4.2. Non-Veridicality in Boys and Girls

Masci et al. [30] highlighted low agreement between motor skill competence perceived by children and their actual skill observed by experts, as the percentage of variance of perceived competence explained by actual competence was low (5% and 6% for locomotor and object control skills, respectively). The authors speculated that this was due to the low accuracy of self-perceptions when cognitive capabilities necessary to make a realistic domain-specific self-evaluation are still immature [43,44]. Substantial evidence suggests that girls have lower perceived and actual ball skill competence than boys as early as young childhood [26,38,39,51,61]. Independently of their actual proficiency level, Masci et al. [30] suggest that girls more frequently underestimated their actual object control skills than boys. The observation that girls more frequently underestimate their actual object control skills compared to boys may be pertinent in light of evidence that object control skills predict involvement in PA and health-related fitness later in life [25,57,62]. Further, evidence suggests that the perception of competence in object control skills mediates the translation of actual MC into health-related outcomes [22,51,62]. The present study supports these findings, but for boys only, where a significant difference ($p < 0.001$) was found between boys' actual and perceived object control skills (Figure 2). Further, Bayes factors confirmed, very strongly, in favour of the alternative vs. null hypothesis ($_{\mathrm{BF}}$: 41). Whilst, conversely, for girls, with regards to object control skills, high veridicality was displayed, with only a small, negative effect size being found (Figure 2).

Masci et al. [30] reported that around one quarter of boys overestimated their object and locomotor control skills more frequently than girls. The present study supports the inference that boys overestimate and girls underestimate MC levels. Interestingly, this study also found that actual levels of locomotor and object control skills were comparable between boys and girls. Despite this, a large sex-mediated discord was evident for girls' locomotor skills, indicating that they systematically under-perceived their actual locomotor competence. Boys, however, systematically over-perceived their actual object control skills. De Meester et al. [63] noted four distinct groups for actual and perceived MC: two groups with high veridicality, i.e., high actual and high perceived, or low actual and low perceived MC. However, the authors also identified a subset of their sample that systematically over- or underestimated its actual MC skill. Interestingly, the strongest correlate of high PA and low BMI was not high actual MC, but high perceived MC. Furthermore, in a comparable population, De Meester et al. [63] found no apparent sex-mediated discord, yet De Meester et al. [32] highlighted this as an issue. Whilst the present study focused on the sex-mediated differences between actual and perceived MC, and not the concept of over- or under-estimation, the present findings are in general concordance with recent evidence [30,63].

4.3. Limitations

One limitation of the present study is its cross-sectional design. Causal inference cannot be assumed regarding actual MC and perceived MC. To gain more insight into these differences and to understand how differences within- and between-the sexes may change or develop over time, longitudinal studies must be conducted. Another possible limitation is the use of a convenience sample, which may result in under- or over-representation of particular groups within a sample but should not detract from the suitably (statistically) powered nature of the study.

5. Conclusions

To the authors' knowledge, this is the first study to assess between- and within-sex differences for actual and perceived locomotor and object control skills. Furthermore, this would appear to be the first study to incorporate Bayes factor inferences in the analyses of children's MC.

The finding that boys' and girls' actual locomotor and actual object control skills are comparable, despite differences in perceptions, is in line with current literature. The novel analytical approach taken in this study to focus on sex-mediated differences in MC adds clarity to an equivocal set of results in the literature. Given the large (effect sizes) and extreme (Bayes factors) differences found between actual and perceived locomotor and object control skills, it is clear that non-veridicality, with regard to MC, in young children is a problem. Further, the propensity of young boys and girls to over or under perceive their PA-related skills, respectively, needs to be acknowledged and addressed by, in particular, schools and key stakeholders in children's PA, and this should be considered in any related intervention. It is advisable that future research considers not only variable and person-centred approaches, but also the clear sex-mediated differences in perceived and actual MC, including its subsets, and the impact on PA.

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Author Contributions: Cain C. T. Clark conceived and designed the experiments; Cain C. T. Clark performed the experiments; Cain C. T. Clark and John F. T. Fernandes analysed the data; Cain C. T. Clark, Benjamin Drury, Fotini Venetsanou, John F. T. Fernandes, and Jason Moran wrote the paper.

Conflicts of Interest: The authors declare no conflict of interest.

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