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Article

Actual vs. Perceived Motor Competence in Children (8-10y): 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 (8-10y). All participants (58 children [29 boys; 9.5±0.6y; 1.44±0.09m; 39.6±9.5kg; 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% CI: -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 (8-10y).

Keywords: Motor Competence; Actual; Perceived; Children; Locomotor; Object Control

1. Introduction

A substantial literature base now affirms the association between childrens' 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 youth 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, 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, Goodway, Langendorfer, Roberton, Rudisill, Garcia and Garcia [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, Goodway, Langendorfer, Roberton, Rudisill, Garcia and Garcia [6] conceptual model. Interestingly, childrens' 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, De Meester, Tallir, Cardon, Lenoir and Haerens [31] and De Meester, *et al.* [32], primary school children had 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 (8-10y).

2. Materials and Methods

97 *Participants and settings*

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

107 *Instruments and Procedures*

108 *Actual motor competence***.** Childrens' actual MC was measured using the Test of Gross Motor
109 Development (2nd edition) (TGMD-2) [48]. The TGMD-2 includes 12 fundamental movement skills
110 (six locomotor, and six object control skills) and takes approximately 20 min to administer. The
111 locomotor subtest consists of running, galloping, hopping, leaping, horizontal jumping and sliding.
112 The object control subtest contains striking a stationary ball, a stationary dribble, catching, kicking,
113 overhand throwing and underhand rolling. Following a visual demonstration, participants were
114 asked to perform each skill twice. The TGMD-2 is a qualitative measure in which each skill is scored
115 against performance criteria prescribed in an accompanying manual (3-5 criteria per skill); the criteria
116 were scored 1 (present) or 0 (absent). Ratings in each item were summed to compute scores for
117 locomotor and object control skills (each score ranging from 0 to 48). The psychometric properties of
118 the TGMD-2 have been evaluated and the manual reports excellent test-retest reliability and inter-
119 rater reliability (r > 0.85) as well as a good internal consistency (Cronbach's α = 0.85 and 0.88 for
120 locomotor and object control subtests respectively). Construct, content and concurrent validity have
121 also been determined for children aged 3 to 10 years [48-50]. Two experienced assessors scored the
122 TGMD-2, with excellent inter-rater reliability (ICC: 0.99).
123
124 *Perceived motor competence*

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

141 *Data analysis*

142 Raw scores for the TGMD-2 and The PSPMSC were transformed into percentiles to facilitate
143 statistical analyses, per manual guidelines [48]. Data were initially assessed for normality using a
144 Shapiro-Wilk test, and found to be normally distributed (P>0.05). Subsequently, between-sex
145 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 H_{10} (alternate hypothesis) relative to H_{01} (null hypothesis; i.e., values larger than 1 are in favour of H_1) assuming that H_{01} and H_{10} are equally likely, were produced. Data were reported as mean±SD, with effect sizes (Cohens's *d*, classified as; small (0.2), medium (0.5), large (0.8), or very large (1.3) [56] and 95% confidence intervals (CI)). 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).

3. Results

Between sex differences

There was no significant difference (P=0.15) found between sexes for actual locomotor skills (F: 69.8±5.27 vs. 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).

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).

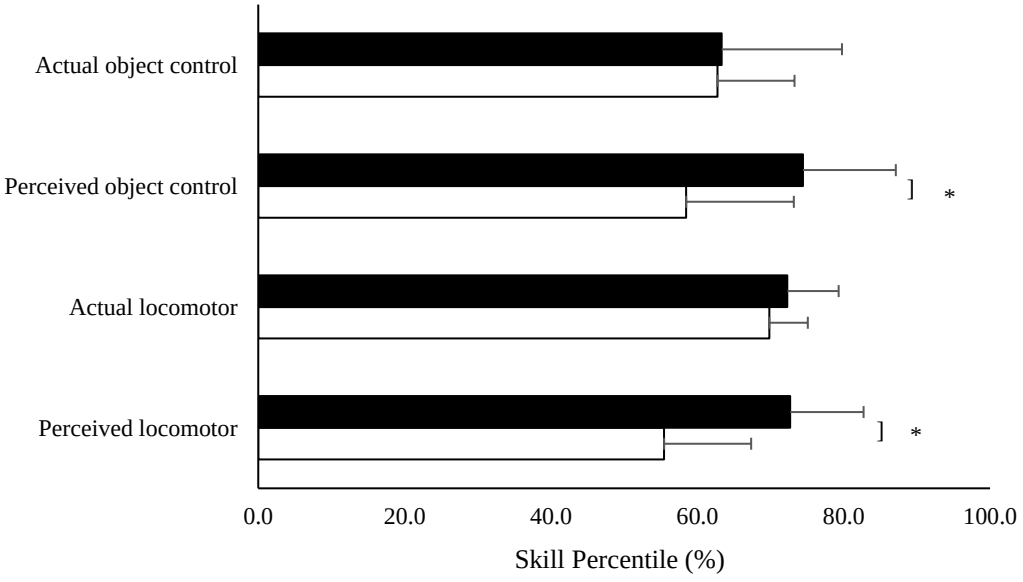

Figure 1. Between-sex perceived and actual, locomotor and object control skill percentile scores. Black bars denote boys; white bars denote girls; * denotes significant difference between sexes (P<0.05).

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).

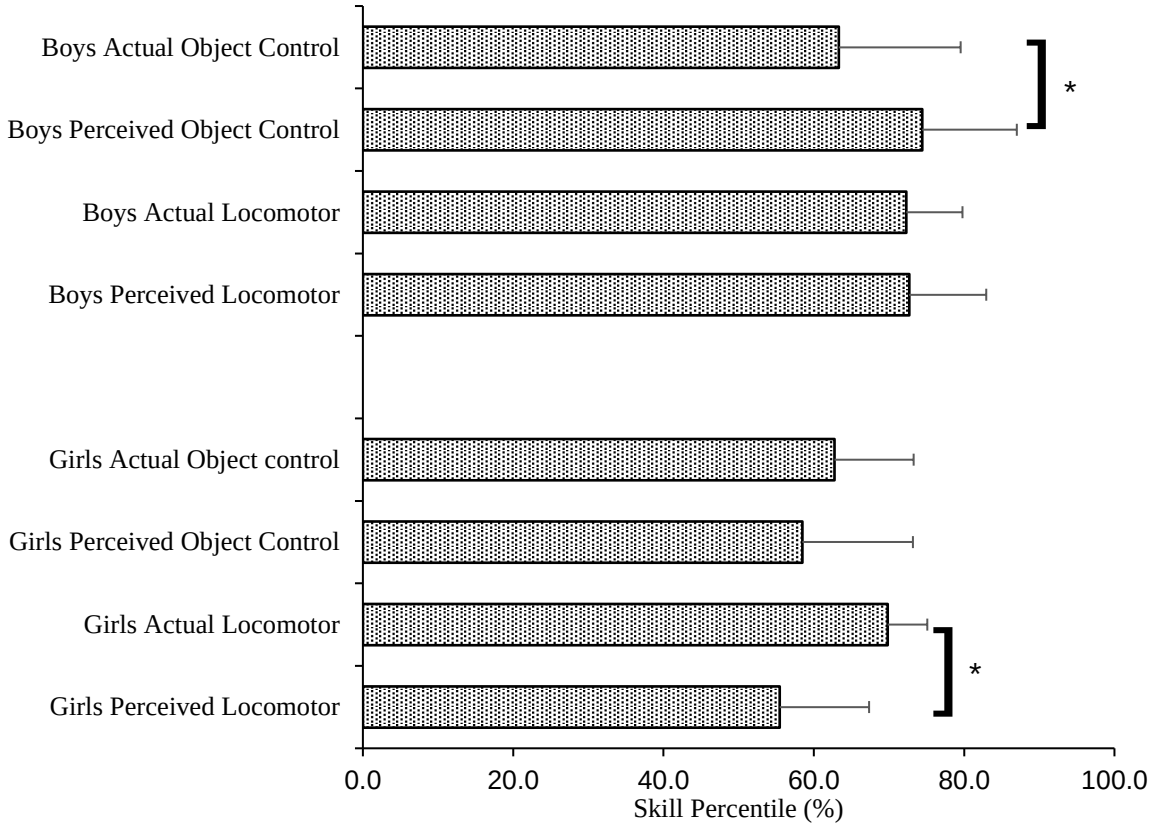

Figure 2. Within-sex differences for perceived and actual locomotor and object control skill percentile scores. * denotes significant difference between actual and perceived scores (P<0.05).

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 (8-10y). 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.

206 **Between-sex differences**

207 Evidence on sex differences in locomotor skills is equivocal [26,36,37,57]. Contentiously, many
208 studies show that girls outperform boys in their locomotor skills [26,38,39], whilst almost an equal
209 number of studies assert that boys have equal [40,41] or higher locomotor skill competence [42]. It is,
210 therefore, unsurprising that the findings of the present study should be equally equivocal for actual
211 MC (locomotor and object control). There was no significant difference (P=0.15) between boys and
212 girls for actual locomotor skills (Figure. 1), highlighting very little discord between actual locomotor
213 skills between sexes. Furthermore, Bayes factors indicated that there was only anecdotal evidence to
214 separate the null and alternate hypotheses. Similarly, there was no significant difference (P=0.87)
215 between sexes for actual object control skills (Figure. 1), further supporting the observations of
216 Bardid, De Meester, Tallir, Cardon, Lenoir and Haerens [31] and Slykerman, Ridgers, Stevenson and
217 Barnett [41].
218 There was a significant difference (P<0.001) found between sexes for perceived locomotor skills,
219 where boys perceived themselves to be ~20 percentage points higher than girls (Figure. 1). This is
220 supported by Bayes factors analysis, which found extreme evidence in favour of the alternative vs.
221 null hypothesis (BF: 55,344). Similarly, boys also perceived their object control skills to be greater than
222 that of the girls with a significant difference (P<0.001) found between sexes (Figure. 1). Bayes factors
223 found 'extreme' evidence in favour of there being a difference between sexes (BF: 460). Whilst the
224 present study highlights differences in perceived, but not in actual, object control and locomotor
225 skills, Brian, *et al.* [58] concluded that there was relatively little sex-related discord for perceived and
226 actual locomotor skills, however there were evident differences for perceived and actual object
227 control skills. This difference is likely influenced by age with Brian, *et al.* [58] assessing 4 to 5 year
228 olds, contrasting with the 8 to 10 year olds in the present study. Concerning the perception of MC,
229 sex-mediated differences are found to proliferate during child development [43,44]. The modal
230 finding in the literature is that boys and girls around the pre-school years display equal perceptions
231 of competence [59,60]. However, from primary school years onward, higher self-perceptions in boys
232 are consistently found [45,46], which supports the findings in the present study.

233 **Non-veridicality in boys and girls**

234 *Masci, Schmidt, Marchetti, Vannozzi and Pesce [30]* highlighted low agreement between motor skill
235 competence perceived by children and their actual skill observed by experts, as the percentage of
236 variance of perceived competence explained by actual competence was low (5% and 6% for locomotor
237 and object control skills, respectively). The authors' speculated that this was due to the low accuracy
238 of self-perceptions when cognitive capabilities necessary to make a realistic domain-specific self-
239 evaluation are still immature *[43,44]*. Substantial evidence suggests that girls have lower perceived
240 and actual ball skill competence than boys as early as young childhood *[26,38,39,51,61]*.
241 Independently of their actual proficiency level, *Masci, Schmidt, Marchetti, Vannozzi and Pesce [30]*
242 suggest that girls more frequently underestimated their actual object control skills than boys. The
243 observation that girls more frequently underestimate their actual object control skills compared to
244 boys may be pertinent in light of evidence that object control skills predict involvement in PA and
245 health related fitness later in life *[25,57,62]*. Further, evidence suggests that the perception of
246 competence in object control skills mediates the translation of actual MC into health-related outcomes
247 *[22,51,62]*. The present study supports these findings, but for boys only, where a significant difference
248 (P<0.001) was found between boys actual and perceived object control skills (Figure. 2). Further,
249 Bayes factors confirmed, very strongly, in favour of the alternative vs. null hypothesis (BF: 41). Whilst,
250 conversely, for girls, with regards to object control skills, high veridicality was displayed, with only
251 a small, negative effect size being found (Figure. 2).
252 *Masci, Schmidt, Marchetti, Vannozzi and Pesce [30]* reported that around one quarter of boys
253 overestimated their object and locomotor control skills more frequently than girls. The present study
254 supports the inference that boys overestimate and girls underestimate MC levels. Interestingly, this
255 study also found that actual levels of locomotor and object control skills were comparable. Despite
256 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 which 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, Maes, Stodden, Cardon, Goodway, Lenoir and Haerens [63]* found no apparent sex-mediated discord, yet *De Meester, Stodden, Brian, True, Cardon, Tallir and Haerens [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]*.

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.

Conclusion

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, respectively, needs to be acknowledged and addressed by, in particular, schools and key stakeholders in childrens' PA and this should be considered in any related intervention. It is advisable that future research considers not only variable and person-centered 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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Supplementary material: Figure 1 (Between-sex perceived and actual, locomotor and object control skill percentile scores) and Figure 2 (Within-sex differences for perceived and actual locomotor and object control skill percentile scores). Research data also supplied as supplementary file.

Author Contributions: CC conceived and designed the experiments; CC performed the experiments; CC and JF analyzed the data; CC, BD, FV, JF and JM wrote the paper.

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References

1. Figueroa, R.; An, R. Motor skill competence and physical activity in preschoolers: A review. *Maternal and child health journal* **2017**, *21*, 136-146.
2. Holfelder, B.; Schott, N. Relationship of fundamental movement skills and physical activity in children and adolescents: A systematic review. *Psychology of sport and exercise* **2014**, *15*, 382-391.

3. Robinson, L.E.; Stodden, D.F.; Barnett, L.M.; Lopes, V.P.; Logan, S.W.; Rodrigues, L.P.; D'Hondt, E. Motor competence and its effect on positive developmental trajectories of health. *Sports medicine* **2015**, *45*, 1273-1284.
4. Clark, C.C.T. Is obesity *actually* non-communicable? *Obesity Medicine* **2017**, *8*, 27-28.
5. Haga, M. The relationship between physical fitness and motor competence in children. *Child: care, health and development* **2008**, *34*, 329-334.
6. Stodden, D.F.; Goodway, J.D.; Langendorfer, S.J.; Roberton, M.A.; Rudisill, M.E.; Garcia, C.; Garcia, L.E. A developmental perspective on the role of motor skill competence in physical activity: An emergent relationship. *Quest* **2008**, *60*, 290-306.
7. Seefeldt, V. Developmental motor patterns: Implications for elementary school physical education. In *Psychology of motor behaviour and sport*, Nadeau, C.; Holliwell, W.; Newell, K.; Roberts, G., Eds. Human Kinetics: Champaign, IL, 1980; pp 314-323.
8. Gallahue, D.L.; Ozmun, J.C.; Goodway, J.D. *Understanding motor development: Infants, children, adolescents, adults*. 7th ed.; McGraw Hill: Boston, MA, 2011.
9. Clark, C.C.T. Profiling movement and gait quality using accelerometry in children's physical activity: Consider quality, not just quantity. *British journal of sports medicine* **2017**.
10. Clark, C.C.T.; Barnes, C.M.; Swindell, N.J.; Holton, M.D.; Bingham, D.D.; Collings, P.J.; Barber, S.E.; Summers, H.D.; Mackintosh, K.A.; Stratton, G. Profiling movement and gait quality characteristics in pre-school children. *Journal of motor behavior* **2017**, 1-9.
11. Barnes, C.M.; Clark, C.C.; Holton, M.D.; Stratton, G.; Summers, H.D. Quantitative time profiling of children's activity and motion. *Medicine and science in sports and exercise* **2017**, *49*, 183-190.
12. Clark, C.C.T.; Barnes, C.M.; Holton, M.D.; Summers, H.D.; Stratton, G. Profiling movement quality and gait characteristics according to body-mass index in children (9–11 y). *Human movement science* **2016**, *49*, 291-300.
13. Clark, C.C.T.; Barnes, C.M.; Summers, H.D.; Mackintosh, K.A.; Stratton, G. Profiling movement quality characteristics of children (9-11y) during recess. *European Journal of Human Movement* **2018**, *39*, 143-160.
14. Garber, C.E.; Blissmer, B.; Deschenes, M.R.; Franklin, B.A.; Lamonte, M.J.; Lee, I.M.; Nieman, D.C.; Swain, D.P.; American College of Sports, M. American college of sports medicine position stand. Quantity and quality of exercise for developing and maintaining cardiorespiratory, musculoskeletal, and neuromotor fitness in apparently healthy adults: Guidance for prescribing exercise. *Medicine and science in sports and exercise* **2011**, *43*, 1334-1359.
15. Metcalf, B.; Henley, W.; Wilkin, T. Republished research: Effectiveness of intervention on physical activity of children: Systematic review and meta-analysis of controlled trials with objectively measured outcomes (earlybird 54). *British journal of sports medicine* **2013**, *47*, 226.
16. Adab, P.; Pallan, M.; Lancashire, E.R.; Hemming, K.; Frew, E.; Barrett, T.; Bhopal, R.; Cade, J.; Canaway, A.; Clarke, J., *et al.* Effectiveness of a childhood obesity prevention programme delivered through schools, targeting 6 and 7 years olds: Cluster randomised controlled trial (waves study). *Bmj* **2018**, *360*.
17. D'Hondt, E.; Deforche, B.; Gentier, I.; Verstuyf, J.; Vaeyens, R.; De Bourdeaudhuij, I.; Philippaerts, R.; Lenoir, M. A longitudinal study of gross motor coordination and weight status in children. *Obesity* **2014**, *22*, 1505-1511.
18. Reinert, K.R.; Po'e, E.K.; Barkin, S.L. The relationship between executive function and obesity in children and adolescents: A systematic literature review. *Journal of obesity* **2013**, *2013*, 820956.

19. Rodrigues, L.P.; Stodden, D.F.; Lopes, V.P. Developmental pathways of change in fitness and motor competence are related to overweight and obesity status at the end of primary school. *Journal of science and medicine in sport / Sports Medicine Australia* **2016**, *19*, 87-92.
20. Lopes, V.P.; Stodden, D.F.; Rodrigues, L.P. Weight status is associated with cross-sectional trajectories of motor co-ordination across childhood. *Child: care, health and development* **2014**, *40*, 891-899.
21. Lubans, D.R.; Morgan, P.J.; Cliff, D.P.; Barnett, L.M.; Okely, A.D. Fundamental movement skills in children and adolescents: Review of associated health benefits. *Sports medicine* **2010**, *40*, 1019-1035.
22. Barnett, L.M.; Van Beurden, E.; Morgan, P.J.; Brooks, L.O.; Beard, J.R. Does childhood motor skill proficiency predict adolescent fitness? *Medicine and science in sports and exercise* **2008**, *40*, 2137-2144.
23. Robinson, L.E.; Stodden, D.F.; Barnett, L.M.; Lopes, V.P.; Logan, S.W.; Rodrigues, L.P.; D'Hondt, E. Motor competence and its effect on positive developmental trajectories of health. *Sports medicine* **2015**, *45*, 1273-1284.
24. Inchley, J.; Kirby, J.; Currie, C. Longitudinal changes in physical self-perceptions and associations with physical activity during adolescence. *Pediatric exercise science* **2011**, *23*, 237-249.
25. Barnett, L.M.; Morgan, P.J.; Van Beurden, E.; Ball, K.; Lubans, D.R. A reverse pathway? Actual and perceived skill proficiency and physical activity. *Medicine and science in sports and exercise* **2011**, *43*, 898-904.
26. Barnett, L.M.; Morgan, P.J.; van Beurden, E.; Beard, J.R. Perceived sports competence mediates the relationship between childhood motor skill proficiency and adolescent physical activity and fitness: A longitudinal assessment. *The international journal of behavioral nutrition and physical activity* **2008**, *5*, 40.
27. Khodaverdi, Z.; Bahram, A.; Khalaji, H.; Kazemnejad, A. Motor skill competence and perceived motor competence: Which best predicts physical activity among girls? *Iranian journal of public health* **2013**, *42*, 1145-1150.
28. Khodaverdi, Z.; Bahram, A.; Robinson, L.E. Correlates of physical activity behaviours in young iranian girls. *Child: care, health and development* **2015**, *41*, 903-910.
29. True, L.; Brian, A.; Goodway, J.; Stodden, D. Relationships between product- and process-oriented measures of motor competence and perceived competence. *Journal of Motor Learning and Development* **2017**, *5*, 319-335.
30. Masci, I.; Schmidt, M.; Marchetti, R.; Vannozzi, G.; Pesce, C. When children's perceived and actual motor competence mismatch: Sport participation and gender differences. *Journal of Motor Learning and Development* **2017**, *0*, 1-33.
31. Bardid, F.; De Meester, A.; Tallir, I.; Cardon, G.; Lenoir, M.; Haerens, L. Configurations of actual and perceived motor competence among children: Associations with motivation for sports and global self-worth. *Human movement science* **2016**, *50*, 1-9.
32. De Meester, A.; Stodden, D.; Brian, A.; True, L.; Cardon, G.; Tallir, I.; Haerens, L. Associations among elementary school children's actual motor competence, perceived motor competence, physical activity and bmi: A cross-sectional study. *PloS one* **2016**, *11*, e0164600.
33. Schmidt, M.; Valkanover, S.; Conzelmann, A. Veridicality of self-concept of strength in male adolescents. *Perceptual and motor skills* **2013**, *116*, 1029-1042.
34. Gortmaker, S.L.; Lee, R.; Cradock, A.L.; Sobol, A.M.; Duncan, D.T.; Wang, Y.C. Disparities in youth physical activity in the united states: 2003-2006. *Medicine and science in sports and exercise* **2012**, *44*, 888-893.

35. Schmutz, E.A.; Leeger-Aschmann, C.S.; Radtke, T.; Muff, S.; Kakebeeke, T.H.; Zysset, A.E.; Messerli-Burgy, N.; Stulb, K.; Arhab, A.; Meyer, A.H., *et al.* Correlates of preschool children's objectively measured physical activity and sedentary behavior: A cross-sectional analysis of the splashy study. *The international journal of behavioral nutrition and physical activity* **2017**, *14*, 1.
36. Barnett, L.; Stodden, D.F.; Cohen, K.E.; Smith, J.J.; Lubans, D.R.; Lenoir, M.; Iivonen, S.; Miller, A.; Laukkanen, A.; Dudley, D.A., *et al.* Fundamental movement skills: An important focus. *Journal of Teaching in Physical Education* **2016**, *Advance Online Publication*.
37. Barnett, L.M.; Lai, S.K.; Veldman, S.L.C.; Hardy, L.L.; Cliff, D.P.; Morgan, P.J.; Zask, A.; Lubans, D.R.; Shultz, S.P.; Ridgers, N.D., *et al.* Correlates of gross motor competence in children and adolescents: A systematic review and meta-analysis. *Sports medicine* **2016**, *46*, 1663-1688.
38. Hardy, L.L.; King, L.; Farrell, L.; Macniven, R.; Howlett, S. Fundamental movement skills among australian preschool children. *Journal of Science and Medicine in Sport* **2010**, *13*, 503-508.
39. Liong, G.H.; Ridgers, N.D.; Barnett, L.M. Associations between skill perceptions and young children's actual fundamental movement skills. *Perceptual and motor skills* **2015**, *120*, 591-603.
40. Bardid, F.; Huyben, F.; Lenoir, M.; Seghers, J.; Martelaer, K.; Goodway, J.; Deconinck, F.J. Asseessment fundamental motor skills in belgian children aged 208 years highlights differences in us reference sample. *Acta paediatrica* **2016**, *105*.
41. Slykerman, S.; Ridgers, N.D.; Stevenson, C.; Barnett, L.M. How important is young children's actual and perceived movement skill competence to their physical activity? *Journal of science and medicine in sport / Sports Medicine Australia* **2016**, *19*, 488-492.
42. Robinson, L.E. The relationship between perceived physical competence and fundamental motor skills in preschool children. *Child Care Hlth Dev* **2011**, *37*, 589-596.
43. Harter, S. The development of self-presentations during childhood and adolescnece. In *Handbook of self and identity*, Leary, M.R.; Tangney, J.P., Eds. Wiley & Sons: New York, 2005.
44. Harter, S. The self. In *Handbook of child psychology: Vol 3. Soical, emotional and persoanlity development*, Damon, R.; Lerner, M.R., Eds. Wiley & sons: New York, 2006.
45. Fredricks, J.A.; Eccles, J. Children's competence and value beliefs from childhood through adolescence: Growth trajectories in two male-sex-typed domains. *Developmental psychology* **2002**, *38*, 519-533.
46. Noordstar, J.J.; van der Net, J.; Jak, S.; Helders, P.J.; Jongmans, M.J. Global self-esteem, perceived athletic comptence, and physical activity in children: A longitudinal cohort study. *Psychology of sport and exercise* **2016**, *22*, 83-90.
47. Jacobs, J.E.; Lanza, S.; Osgood, D.W.; Eccles, J.S.; Wigfield, A. Changes in children's self-competence and values: Gender and domain differences across grades one through twelve. *Child development* **2002**, *73*, 509-527.
48. Ulrich, D.A. *Test of gross motor development: Examiner's manual* 2nd ed.; PRO-ED: Austin, Texas, 2000.
49. Kim, C.; Han, D.; Park, I. Reliability and validity of the test of gross motor development-2 in korean preschool children. *Research in developmental disabilities* **2014**, *2*, 2-9.
50. Valentini, N. Validity and relaibility of the tgmd-2 for brazilian children. *Journal of Motor Behaviour* **2012**, *44*, 275-280.
51. Barnett, L.M.; Ridgers, N.D.; Salmon, J. Associations between young children's perceived and actual ball skill competence and physical activity. *Journal of Science and Medicine in Sport* **2014**.

52. Barnett, L.M.; Robinson, L.E.; Webster, E.K.; Ridgers, N.D. Reliability of the pictorial scale of perceived movement skill competence in 2 diverse samples of young children. *Journal of physical activity & health* **2015**, *12*, 1045-1051.
53. Wagenmakers, E.J.; Marsman, M.; Jamil, T.; Ly, A.; Verhagen, J.; Love, J.; Selker, R.; Gronau, Q.F.; Smira, M.; Epskamp, S., *et al.* Bayesian inference for psychology. Part i: Theoretical advantages and practical ramifications. *Psychon Bull Rev* **2017**.
54. Wagenmakers, E.J.; Love, J.; Marsman, M.; Jamil, T.; Ly, A.; Verhagen, J.; Selker, R.; Gronau, Q.F.; Dropmann, D.; Boutin, B., *et al.* Bayesian inference for psychology. Part ii: Example applications with jasp. *Psychon Bull Rev* **2017**.
55. Marsman, M.; Wagenmakers, E.J. Bayesian benefits with jasp. *European Journal of Developmental Psychology* **2016**, *14*, 545-555.
56. Cohen, J. *Statistical power analysis for the behavioral sciences*. 3rd. ed.; Lawrence Erlbaum Associates: New York, 1988.
57. Barnett, L.M.; Ridgers, N.D.; Hesketh, K.; Salmon, J. Setting them up for lifetime activity: Play competence perceptions and physical activity in young children. *Journal of science and medicine in sport / Sports Medicine Australia* **2017**, *20*, 856-860.
58. Brian, A.; Bardid, F.; Barnett, L.; Deconinck, F.J.; Lenoir, M.; Goodway, J. Actual and perceived motor competence levels of belgian and us preschool children. *Journal of Motor Learning and Development* **2017**, *0*, 1-29.
59. Breslin, G.; Murphy, M.; McKee, D.; Delaney, B.; Dempster, M. The effect of teachers trained in a fundamental movement skills programme on children's slef-perceptions and motor competence. *European Physical Education Review* **2012**, *18*, 114-126.
60. Crane, J.R.; Naylor, P.J.; Cook, R.; Temple, V.A. Do perceptions of competence mediate the relationship between fundamental motor skill proficiency and physical activity levels of children in kindergarten? *Journal of physical activity & health* **2015**, *12*, 954-961.
61. Barnett, L.M.; Ridgers, N.D.; Zask, A.; Salmon, J. Face validity and reliability of a pictorial instrument for assessing fundamental movement skill perceived competence in young children. *Journal of science and medicine in sport / Sports Medicine Australia* **2015**, *18*, 98-102.
62. Barnett, L.M.; van Beurden, E.; Morgan, P.J.; Brooks, L.O.; Beard, J.R. Childhood motor skill proficiency as a predictor of adolescent physical activity. *The Journal of adolescent health : official publication of the Society for Adolescent Medicine* **2009**, *44*, 252-259.
63. De Meester, A.; Maes, J.; Stodden, D.; Cardon, G.; Goodway, J.; Lenoir, M.; Haerens, L. Identifying profiles of actual and perceived motor competence among adolescents: Associations with motivation, physical activity, and sports participation. *Journal of sports sciences* **2016**, *34*, 2027-2037.