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Perceived motor competence in early childhood predicts perceived and actual motor competence in middle childhood

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The study aims were to (1) identify perceived motor competence (PMC) and actual motor competence (AMC) profiles in children at two time points (early and middle childhood) 3 years apart, (2) explore transitions between the profiles from T1 to T2, and (3) investigate how PMC-AMC profiles at T1 differ in their mean values for AMC and PMC variables at T2. PMC was assessed by the pictorial scale of Perceived Movement Skill Competence for young children (PMSC). At T1, AMC was measured with Test of Gross Motor Development–third version (TGMD-3), and at T2, a shortened TGMD-3 was used. To identify the PMC-AMC profiles using latent profile analysis, the Mplus statistical package (version 8.7) was used. For aim 3, the Bolck-Croon-Hagenaars (BCH) method was used. There were 480 children (mean age 6.26 years, 51.9% boys) at T1, 647 children (mean age 8.76 years, 48.8% boys) at T2 (some children were too young to have the PMC assessment at T1), and 292 at both time points. For aim 1, three profiles were identified at each time point for each gender. Boys had two realistic profiles with medium and low levels of PMC-AMC, and an overestimation profile. Girls had a medium realistic profile, an overestimation, and an underestimation profile. The PMC-AMC profile in early childhood predicted the PMC-AMC profile (aim 2) and AMC and PMC variables (aim 3) in middle childhood, especially if a child had low PMC in early childhood. Children with low PMC in early childhood are at risk of low PMC and less AMC development in middle childhood.

KEYWORDS
children, gross motor skills, longitudinal study, motor skills, perceived motor competence, profiles

1 | INTRODUCTION

Perceived motor competence (PMC) can be defined as a child's awareness and beliefs in his/her capabilities to execute given motor tasks.[1,2] In a framework of the spiral of engagement towards physically active lifestyle,[3] the role of PMC is mediating the relationship between physical activity (PA) and actual motor competence (AMC). Thus, if the child believes (s)he will manage to execute given motor tasks, this may lead to increased engagement towards PA, which can develop his/her AMC. On the other hand, AMC refers to a child's degree of proficiency in executing different motor skills, as well as the mechanisms accentuating this performance (e.g., motor coordination and control).[2] Sufficient AMC is considered important for PA engagement, and is hypothesized to directly or indirectly impact an individual's capacity to engage in PA throughout the lifespan.[4] Cross-sectional studies have reported that developing AMC in early childhood may be associated with children's PA,[5,6] healthy body weight and fitness,[2,3] body composition,[5,7] PMC,[8] and cognitive and academic skills.[9]

High and aligned levels of AMC and PMC seem to be key for engaging children in PA and sports.[2,10–12] According to several frameworks,[2,3,7] there is a reciprocal relationship between PA, PMC, and AMC (i.e., PA can influence PMC and AMC, while PMC and AMC can also predict PA). In early childhood, children tend to have a high level of PMC,[2,3,13] which does not accurately match their AMC.[5] By the time children go to school, in general, the level of children's PMC tends to decrease[3,14,15] while AMC tends to increase.[10] This converse development of AMC and PMC is due to divergent development of these two factors; AMC increases due to the biological maturation of the child's body and musculoskeletal system,[10,16,17] and growing efforts of PA including the acquisition of motor skills,[2,3,17] but PMC development is more related to cognitive capacity.[14] PMC development (often the decline of PMC) is caused by changes in the child's cognitive capacity, which permits the child, on one hand, to understand more abstract concepts as a function of age,[14] and on the other hand, to use different sources of information from internal feedback (e.g., "do I manage to execute given task?") and parental feedback[15,18] to peer comparison ("compared to my classmates, how good am I?").[14,15,18]

The relationship between PMC and AMC can be studied in different ways. A variable-centered approach reports associations between PMC and AMC providing an overall picture of the relationship between these two variables.[5,12] However, to understand the relationship between PMC and AMC in more depth, alternative approaches are needed as not all children gain their PMC and AMC similarly. Therefore, some recent studies have used a person-centered approach focusing on identifying those groups that share attributes or relations among the attributes.[5,12] A person-centered approach could be one way to explain some of the inconsistent findings[19] in the overall picture. Consequently, most recent studies have recommended the use of a person-centered approach[5,12,15] and more longitudinal data[8] to understand the causal pathway.

Both PMC and AMC development are age-related but not age determined.[2] In the PMC (profile) research, the PMC is usually reported based on the "level" of PMC or "accuracy" of PMC related to AMC. The child's PMC level is usually measured by how high or low the child rates their AMC while the accuracy refers to the alignment between the perception and actual motor skill.[15] In past research, both standpoints are used, and considered as important for understanding achievement behaviors, cognitions, and affect.[15] Past evidence has shown for example, that high levels of PMC and AMC predicted higher global self-worth in children while lower PMC was associated with lower levels of global self-worth.[12] Another study reported that both high PMC and AMC were associated with higher PA levels and lower weight status.[5] Both studies demonstrate that aligned high PMC and AMC levels are associated with health benefits for children; however, there is scarce knowledge on whether higher PMC or a more aligned—and more realistic—relationship between PMC and AMC is more efficient in providing children potential health benefits.[20]

One way of enlarging the understanding of the relationship between AMC and PMC with a person-centered approach has been the study of different profiles.[5,20,21] The PMC profiles in the past have been identified based on the accuracy of the estimation (realistic, over-, or underestimation)[20,21] or based on the alignment between PMC and AMC (e.g., aligned, aligned-partially, non-aligned).[5,8,12] In short, in these studies, the focus has been in the identification of the profiles, as well as explaining the associations of the profiles to other factors, such as motivation towards sport,[12] autonomous motivation towards PA,[6] PA,[5,6] sport participation,[20] and weight status.[5]

In a study by Pesce and colleagues[20] three profiles were identified: underestimators, realists, and overestimators. Profiles differed according to gender, with most girls underestimating and most boys overestimating their ball skills. Profiles also differed according to sport participation, with the overestimation profile of locomotor competence practicing a larger amount of sport than the underestimation profile.[20] Inspired by these past studies,[5,12,20,21] the authors of a longitudinal profile study identified profiles separately for boys and girls.[8] The authors reported that regardless of gender, high PMC and AMC and physical fitness were associated with higher PA participation and lower weight status[8] supporting the findings of previous cross-sectional studies,[5] and past frameworks.[2,3]

Previous cross-sectional studies have revealed different PMC-AMC profiles,[5,12,20–22] some of which differ by gender.[20,22] However, cross-sectional studies cannot provide evidence regarding the development of PMC-AMC profiles across time. Only a handful of studies[8] have examined the relationship between PMC-AMC profiles in longitudinal studies, and they have had relatively modest sample sizes. The current study is novel also because it provided an opportunity to determine whether PMC-AMC profiles in children aged 5–7 years at T1 differed in the mean values of AMC and PMC variables at T2. Therefore, the purpose of this study was to expand the understanding of PMC-AMC development by (1) exploring if divergent profiles could be identified during early (time 1) and middle childhood (time 2), (2) analyzing the changes in the profiles across time, and (3) investigating mean values of AMC and PMC variables at T2 based on PMC-AMC profiles at T1.

2 | MATERIALS AND METHODS

2.1 | Study design

The data were obtained from two studies: Skilled Kids (early childhood, time 1) and Active Family (middle childhood, time 2). The baseline data collection (T1) was conducted during the years 2015-2016, and the follow-up study (T2) during 2018-2020 with the same children and their legal guardians. Data were collected at two time points 3 years apart to capture the transitional time from when children are attending ECEC centers to their first years at school.

The Skilled Kids study (T1) and its data collection and cluster-random sampling have been previously described in detail in other publications of the projects.[23] In short, during early childhood, a geographically representative sample of 1000 children, aged 3–7 years, was recruited from Finnish early childhood education and care (ECEC) centers. In 2015, ECEC centers were selected using a cluster-random sampling of a potential 2600 ECEC centers from the Finnish national registry of early educators all over Finland representing different geographical locations and residential densities of living places. In total, 37 ECEC centers participated: 17 located in Southern, 13 in Central, and seven in Northern Finland.[21,23] As PMC was assessed only with children aged 5 or more years, the data of the current study, includes only children over 5 years.

Data collection at T1 took place during a typical ECEC day. Children were informed of study activities and their right to opt out of participation. The Ethics Committee of the University of Jyväskylä granted ethical approval for the Skilled Kids study on October 31, 2015 (Skilled Kids, 31.10.2015). Active Family (T2) followed the same children and their legal guardians 3 years later from T1. In total, 97 different primary schools, and 666 children participated (~70% from T1). The Ethics Committee of the University of Jyväskylä granted ethical approval for the T2 on June 28, 2018 (Active Family, 28.06.2018). The data collection was executed during a typical school day in a real school setting.

2.2 | Participants

At T1, 480 children participated (mean age 6.26 years) of which 51.9% were boys ($n=249$, mean age 6.27 years) and 48.1% were girls ($n=231$, mean age 6.26 years). At T2, 647 children participated in the study (mean age 8.76 years) of which 48.8% were boys ($n=316$, mean age 8.80 years) and 51.2% were girls ($n=331$, mean age 8.72 years). In the analysis of transitions between the profiles from T1 to T2, a total of 292 children were included.

2.3 | Assessment tools

The child's age and gender were queried via parental questionnaire. In the analyses, the exact decimal age of the child was used.

PMC was evaluated using the Pictorial Movement Skill Competence (PMSC) scale designed for children from 5 years old.[24] The PMSC used in this study was a modified version[25] matched to align with Test of Gross Motor Development–third version (TGMD-3),[26] which was used in the current study to assess AMC. This PMSC version has 13 skills of which six concerned perceptions related to locomotor skills (run, gallop, hop, skip, horizontal jump, and slide) and seven related to perceptions of ball skills (two-hand strike of a stationary ball, one-hand forehand strike, one-hand stationary dribble, two-hand catch, kicking a stationary ball, overhand throw, and underhand throw). Each skill item was evaluated from 1 to 4 points leading to a maximum sum score for locomotor skills of 24 points (6×4) and for the perception of ball skills, 28 points (7×4) using a dichotomous two-step choice process to arrive at one of four responses (1 = not that good, 2 = sort of good, 3 = pretty good, 4 = really good) per each skill. The maximum total score was 52 points. The higher the child scored; the higher the child's PMC resulted to be. Previous studies have demonstrated good reliability and validity for assessing young children's PMC with PMSC in different cultures for locomotor skills,[27] ball skills,[25,27] and in all 13 skills.[27] At T1, the PMSC's test–retest reliability was assessed over 14 days with 53 children. The intra-class correlation (ICC) estimate considering the total PMSC was

0.85 (95% CI = 0.76–0.91), indicating a good test–retest reliability.[21,23] At T2, a supervised group administration was used due to the older age of the children. This approach is recommended for use with children over 8 years. Also, research has found good-to-excellent agreement between both types of administrations, but higher internal consistency has been captured for group administration in older children.[28]

The TGMD-3 is an AMC measure that evaluates the quality of 13 locomotor and ball skills (same skills as described in the PMSC). In early childhood (T1), the complete TGMD-3 was used[26] and all children aged 5–7 years completed the TGMD-3 measurements.[29] In locomotor skills, the maximum points were 46 points and, in ball skills, 54 points. These subcategories are summed into a TGMD-3 gross motor index, with a theoretical maximum of 100 points. At T1, excellent interrater reliability ($n = 167$) between two trained observers in the gross motor index (0.88, 95% CI = 0.85–0.92) has been reported.[23] At T2, a shortened TGMD-3 was used, including two locomotor skills (hop, skip) and two ball skills (dribble, overhand throw) with a theoretical maximum of 28 points (14 from locomotor and ball skills). The chosen skills have been reported previously to be among the best loading items on factors of locomotor and ball skills in 3-10-year-old children,[30] and the same has been found in a sample of 3-11-years old Finnish children ($n = 371$) *(unpublished)*. Otherwise, the protocol of locomotor and ball skills followed the protocol stated in the manual of TGMD-3,[26] also followed at T1.

2.4 | Statistical analyses

Locomotor and ball skill variables from PMC and AMC were used to find latent classes using T1, and T2 data separately. The differences between latent classes were allowed to appear in the mean and variances leading to latent profile analysis (LPA),[31] which is one submodel in the finite mixture modeling.[32] Observation in each latent class has the assumption of being normally distributed and the differences between classes are restricted to only mean and variances. This restriction means that variables did not correlate within groups. Used variables in the latent profile analysis were age-adjusted using standardized residuals from regression analyses (IBM SPSS). The first step in the latent profile analysis was to fit one to k number of latent classes to the data and to evaluate, firstly, which of the models statistically fitted the data best, and secondly, which of the identified solutions would be theoretically meaningful to describe the data. The fit between models was compared using Bayesian information criteria (BIC) and Lo-Mendel-Rubin adjusted test (LMR). In essence, the lower the BIC value, the better the model fitted to the data. In LMR, a statistically significant test value meant that k number of latent classes fitted the data better compared with k-1 number of latent classes. After deciding the number of latent classes, a distinction between latent classes was evaluated with average latent class probabilities where value <0.70 indicated a lack of distinctiveness between the profiles. Alternatively, the higher the value, the more generalizable the profiles are.

For aim 1, to identify the PMC-AMC profiles at T1 and T2, the analyses initially attempted to find the best-fitted number of latent classes separately firstly, for girls and boys, and secondly, for T1 and T2 data. If the number of latent classes was equal for girls and boys, the latent classes were compared between gender in successive steps (equality of mean values, equality of variances, and equality of latent class sizes).[33] Thus, multiple-group LPA models for boys and girls were estimated simultaneously using the known class specification for gender in Mplus. This made the comparison between girls and boys possible. For aim 2, to analyze the transitions between the PMC-AMC profiles from T1 to T2, latent profile analysis was continued combining the latent classes from the T1 and T2 to estimate the transition probabilities from T1 data classes to T2 classes. When comparing the similarity of profiles between gender and when doing transition analysis, only the BIC was available. For aim 3, to analyze how the PMC-AMC at T1 predicted the level of AMC and PMC at T2, the Bolck-Croon-Hagenaars (BCH) method was used.[34] BCH method was implemented in Mplus as it does not change the latent classes and it is recommended to use when comparing mean values of auxiliary variables between latent classes. All the models were estimated using a full information maximum likelihood method with Mplus 8.7 program.[35] The missing values were supposed to be missing at random. We used robust standard error estimation (MLR estimator in Mplus) to address the potential non-normality of the data distribution.

3 | RESULTS

3.1 | Aim 1: The development of the PMC-AMC profiles

3.1.1 | The development of the profiles at T1

In the first stage, latent profile analysis identified the best-fitted models for boys and girls separately at T1. Table 1 shows BIC and LMR test results for one- to five-class solutions in the T1 data. For girls, the BIC value

TABLE 1 Fit information for girls and boys at time 1 (T1; Skilled Kids) and at time 2 (T2; Active Family).

Skilled Kids (T1)				
Number of latent classes	Girls		Boys	
	BIC	LMR	BIC	LMR
1	2473.638	NA	2798.537	NA
2	2363.418	<0.001	2662.749	0.012
3	2313.757	<0.001	2621.674	0.018
4	2297.688	0.071	2623.937	0.132
5	2310.133	0.141	2628.816	0.202
Active Family (T2)				
1	3540.125	NA	3666.283	NA
2	3483.454	0.001	3483.454	<0.001
3	3336.202	0.068	3427.822	0.014
4	3336.415	0.026	3413.816	0.021
5	3346.158	0.105	3421.894	0.009
			3440.883	0.114

Note: BIC is Bayesian information criteria, and LMR is the adjusted Lo–Mendell–Rubin likelihood ratio test.
Abbreviation: NA, not applicable.

showed that a four-latent class solution was a better fit to the data, compared with the three-class solution, whereas the LMR test suggested that the three-class solution was the best fit. Due to similarity in profiles, and small class sizes, the three-class solution was selected for further analysis. For boys, both the BIC and LMR tests showed that a three-class solution was a better fit to the data. The three-class solution for girls and boys showed divergent mean values according to multigroup analysis (BIC for the freely estimated model was 5642.43 and for equally set mean values 5716.13).

3.1.2 | The development of the profiles at T2

Secondly, latent profile analysis was used to find the best-fitted models for boys and girls at T2 separately. Table 2 shows BIC and LMR test results for one- to six-class solutions. For girls, the BIC value showed that a four-latent class solution fitted the data best, whereas the LMR test found the three-class solution the best-fitting model. For boys, BIC showed that the four-class solution fitted the best to the data, whereas the LMR test found the five-class solution the best-fitting model. Because two of the profiles in the five- and four-class solutions resulted in similar values and those class sizes were small, the four- and three-class solutions were analyzed further. Comparing the four-class solution between girls and boys showed that the mean values differed between girls and boys according to multigroup analysis (BIC for a freely estimated model was 7736.95 and for equally set mean values 7771.08). Comparing the three-class solution between girls and boys showed that the mean values differed between girls and boys (BIC for a freely estimated model was 7705.14 and for equally set mean values 7815.28). Because the mean values between girls and boys were different at both time points, the latent profile analysis was estimated separately for girls and boys.

3.1.3 | The profiles of boys at T1 and T2

When estimating the latent profile analysis for boys as specified above, the three-class solution was further analyzed at T2, even though the four-class solution fitted the data best. When the four-class solution was investigated more in detail, there was a small ($n = 17$) number of children in the fourth profile. Thus, the three-class solution was used to avoid theoretical overlaps of the profiles and to enhance readability. The PMC and AMC levels were investigated using SD values in perceived and actual locomotor and ball skills at T1, and T2 as follows; low value was given when SD ≤ -0.5, medium when SD $= -0.5$ to 1.0, and high when SD $=>1.0$. In each profile, both perceived locomotor and ball skills were between similar SD values that were used in the denomination of the profiles; however, the values in AMC differed for locomotor and ball skills within the profiles. Gender differences were observed for all profiles. For example, boys' actual ball skills were higher than their actual locomotor skills. Alternatively, girls' actual ball skills were lower than their locomotor skills in each profile. However, there were some differences according to the type of AMC within the profiles. Finally, in line with previous studies, the PMC-AMC profiles were identified based on the accuracy of the estimation.[20,21] If PMC was higher than AMC, the profile was called "overestimation." If the PMC and AMC were aligned, the profile was called "realistic." Finally, if the PMC was lower than the AMC, the profile was called "underestimation."

TABLE 2 Bayesian information criteria for different combinations of T1 (time 1; Skilled Kids) and T2 (time 2; Active Family) models.

Boys			Girls		
Number of latent classes			Number of latent classes		
T1	T2	BIC	T1	T2	BIC
1	1	6471.201	1	1	6020.336
1	2	6290.890	1	2	5864.109
1	3	6237.776	1	3	5820.571
1	4	6226.288	1	4	5822.863
1	5	6236.883			
2	1	6340.076	2	1	5915.605
2	2	6147.615	2	2	5758.132
2	3	6097.580	2	3	5719.374
2	4	6086.596	2	4	5727.024
2	5	6107.98			
3	1	6303.663	3	1	5871.087
3	2	6101.167	3	2	5699.358
3	3	6050.231	3	3	5666.324
3	4	6043.023	3	4	5705.385
3	5	6072.661			
4	1	6310.588	4	1	5860.937
4	2	6115.073	4	2	5693.844
4	3	6070.059	4	3	5683.283
4	4	6070.157	4	4	5714.305

Abbreviation: BIC, Bayesian information criteria.

According to average latent class probabilities, an overestimation profile (high–medium) at T1, a realistic (low) profile at T2, and an overestimation profile (high–medium) at T2, were clearly distinctive from other profiles. Within these profiles, individuals had high probabilities to belong to these profiles. Average latent class probabilities at T1 were 0.78 and 0.75 for the realistic (low) profile, and the realistic (medium) profile, respectively. At T2, latent class probabilities were 0.89 and 0.79 for the overestimation (high–medium) and realistic (medium) profiles, respectively, showing distinctiveness.

The study of the profiles across two time points revealed three (T1 and T2) profiles for boys. Boys had two realistic profiles at both time points: realistic (medium) profile at T1 and T2 (T1 $n=190$, and T2 $n=194$) and realistic (low) profile at T1 and T2 (T1 $n=115$, and T2 $n=162$). Also, at both time points, there was an overestimation profile (high PMC and medium AMC) (T1 $n=116$, and T2 $n=61$). In all three profiles, boys tended to have higher perceptions of ball skills and higher actual ball skills than locomotor skills. However, only one difference occurred according to the type of AMC. In the realistic (low) at T2 profile, boys were realistic (low) in locomotor skills but underestimated their ball skills (low-medium). See Figure 1.

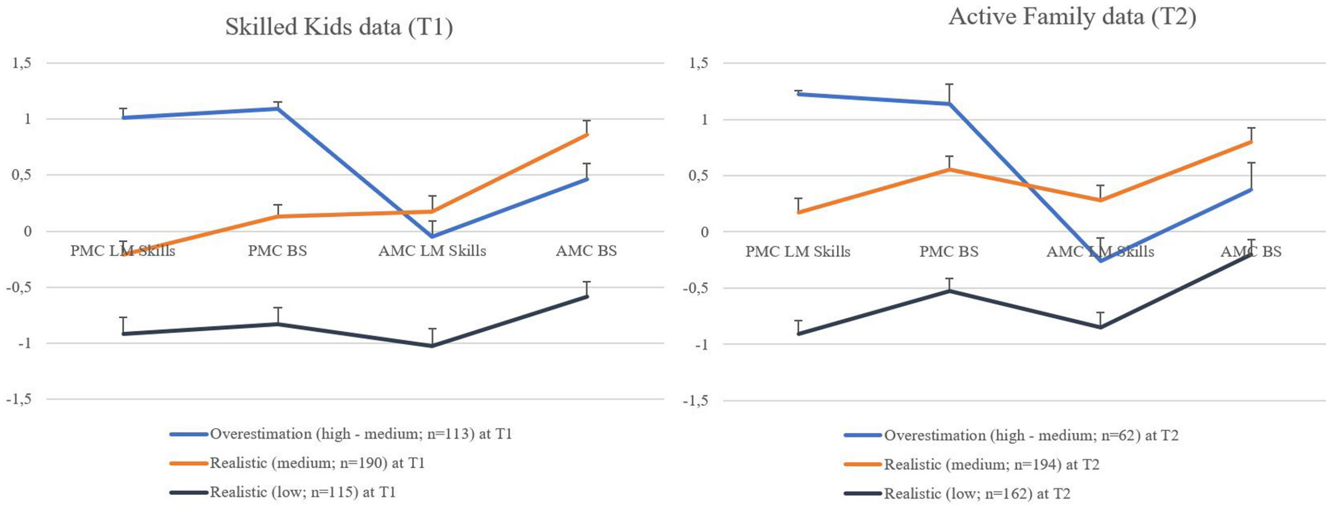

FIGURE 1 Perceived motor competence (PMC) and actual motor competence (AMC) latent class mean profiles for locomotor (LM) and ball skills (BS) at time 1 (T1, early childhood) and at time 2 (T2, middle childhood) for boys.

3.1.4 | The profiles of girls at T1 and T2

When estimating the LPA for girls with combined data, the combination of three-class solution at time T1 and T2 fitted the data best (see Table 3). According to average latent class probabilities, overestimation (high–medium) at T1 (0.95), underestimation (low–medium) at T2, and overestimation (high–medium) at T2 (0.92 and 0.96), were clearly distinctive from other profiles. Within these profiles, individuals had high probabilities belonging to these profiles. Average latent class probabilities at T1 were 0.79 and 0.84 for the underestimation (low–medium) profile at T1, and realistic (medium) at T1, and at T2, 0.84 for realistic (medium) profile showing distinctiveness.

Girls had realistic profiles across time, having medium PMC and AMC at T1 ($n=216$) and at T2 ($n=194$). Additionally, at both time points two other profiles were found. There was a small overestimation profile resulting in high PMC and medium AMC at T1 and T2 (T1 $n=49$, and T2 $n=16$). Also, an underestimation profile was found at both time points (T1 $n=152$, and T2 $n=207$) resulting in low PMC and medium AMC.

In each profile, girls had a medium level of AMC; only the PMC varied and its association with AMC. Thus, the differences between the profiles were formed based on the PMC of the child. The level of AMC was similar in locomotor and ball skills within the profiles at T1. At T2, the AMC differences between the profiles grew slightly, and only one difference occurred according to the type of AMC. Girls in the underestimation profile (low–medium) at T2, underestimated their locomotor skills (low–medium) but were realistic in the assessment of their balls skills (low). See Figure 2.

3.2 | Aim 2: PMC-AMC profile transitions from T1 to T2

3.2.1 | Profile transitions for boys

In boys, the highest permanence of the profile shape was in the realistic (low) profile as 92.2% of the boys who had low PMC and AMC in early childhood (T1) had the same realistic (low) level profile in middle childhood. Also, the realistic (medium) profile at T1 was stable, as the majority (71.4%) of the boys remained in this profile at T2. However, some of the boys (15.3%) changed their profile from a realistic (medium) to an overestimation (high–medium) profile, while 13.3% of the realistic (medium) profiles' boys transferred into a realistic (low) profile at T2.

Overestimation profile had the strongest turnover, as only 20.9% of the boys overestimating their AMC skills at T1, belonged to the same overestimation profile at T2. Most of these boys (79%) were included in the realistic profiles during the middle childhood (realistic [medium, 51.4%] or realistic [low, 27.6%] at T2). This result showed that most of the boys overestimating their AMC skills in early childhood tended to decline in the level of PMC (realistic [medium] profile, 51.4%) while 27.6% of these boys declined in their levels of both AMC and PMC (realistic [low]). See Table 4.

3.2.2 | Profile transitions for girls

In general, girls had stable permanence in two (underestimation and realistic) of the three profiles. Nearly all girls (92.5%) that were identified in the underestimation profile in early childhood, had the same underestimation profile in middle childhood. At T1, most of the girls (69.1%) in realistic profile, had the same realistic PMC-AMC profile at T2. However, the overestimation profile did not predict at all (0%) the permanence of overestimation profile in girls from early to middle childhood. Most of the girls (67.7%) that were overestimating their AMC skills at T1 were identified in the realistic profile at T2, while almost a third (32.3%) were identified as underestimators. Thus, in girls, the overestimation of AMC skills seems to decrease as a function of age.

3.3 | Aim 3: Mean values of AMC and PMC variables at T2 based on PMC-AMC profiles at T1

Overall, boys and girls in the realistic (medium) and overestimation profiles at T1 had the highest actual and perceived locomotor and ball skills at T2. The realistic (low) profile in boys and underestimation profile in girls had lower perceived and actual locomotor and ball skills at T2 than other profiles. No other differences were found between the profiles. More specifically, in relation to AMC level at T2, boys with a realistic (low) profile at T1 had significantly lower actual locomotor and ball skill level at T2, compared with boys in the realistic (medium; $p<0.001$ and $p<0.001$, respectively) and overestimation ($p<0.001$ and $p=0.001$, respectively) profiles. In girls, only one statistically significant difference between the profiles was found, that is, the realistic (medium) profile at T1 had higher actual locomotor skills at T2 than the girls in underestimation profile ($p=0.001$).

In relation to PMC level at T2, boys with a realistic (low) profile at T1 had significantly lower perceived locomotor skills at T2, compared with boys with realistic (medium; $p<0.001$ and $p<0.001$, respectively) and

TABLE 3 Mean (M) and standard deviation (SD) of latent classes across time for boys and girls.

	Time 1						Time 2					
	Realistic (low; $n=115$)		Realistic (medium; $n=190$)		Overestimation (high–medium; $n=116$)		Realistic (low; $n=162$)		Realistic (medium; $n=194$)		Overestimation (high–medium; $n=61$)	
Boys	**M**	**SD**	**M**	**SD**	**M**	**SD**	**M**	**SD**	**M**	**SD**	**M**	**SD**
PMC LM skills (max. 24 p.)	17.10	2.97	19.33	2.47	23.16	1.01	17.10	3.11	20.42	2.10	23.62	0.35
PMC BS (max. 28 p.)	18.60	3.91	22.72	2.77	26.84	1.20	20.33	3.43	24.63	2.29	26.93	1.16
AMC LM skills (max. 46 p.)	24.41	5.87	31.72	4.96	30.34	5.94	21.57	8.92	31.88	7.89	26.94	9.87
AMC BS (max. 54 p.)	24.50	5.81	35.23	5.44	32.28	7.00	29.61	12.99	41.66	8.22	36.54	10.83
	Underestimation (low–medium; $n=152$)		Realistic (medium; $n=216$)		Overestimation (high–medium; $n=49$)		Underestimation (low–medium; $n=207$)		Realistic (medium; $n=194$)		Overestimation (high–medium; $n=16$)	
Girls	**M**	**SD**	**M**	**SD**	**M**	**SD**	**M**	**SD**	**M**	**SD**	**M**	**SD**
PMC LM skills (max. 24 p.)	17.66	2.68	21.48	1.62	23.63	0.47	18.20	2.34	21.92	1.59	23.59	0.11
PMC BS (max. 28 p.)	17.74	3.10	23.16	2.64	27.87	0.23	18.66	3.23	24.15	2.29	27.85	0.04
AMC LM skills (max. 46 p.)	31.78	5.55	32.28	5.51	32.24	5.05	29.61	7.67	32.78	7.57	35.24	7.30
AMC BS (max. 54 p.)	25.44	6.70	26.62	6.00	26.68	5.56	24.58	10.27	30.87	9.64	35.32	10.62

Note: Time 1 (T1), time 2 (T2), perceived motor competence (PMC), actual motor competence (AMC), locomotor (LM), ball skills (BS), maximum (max.), points (p.), and number of children (n).

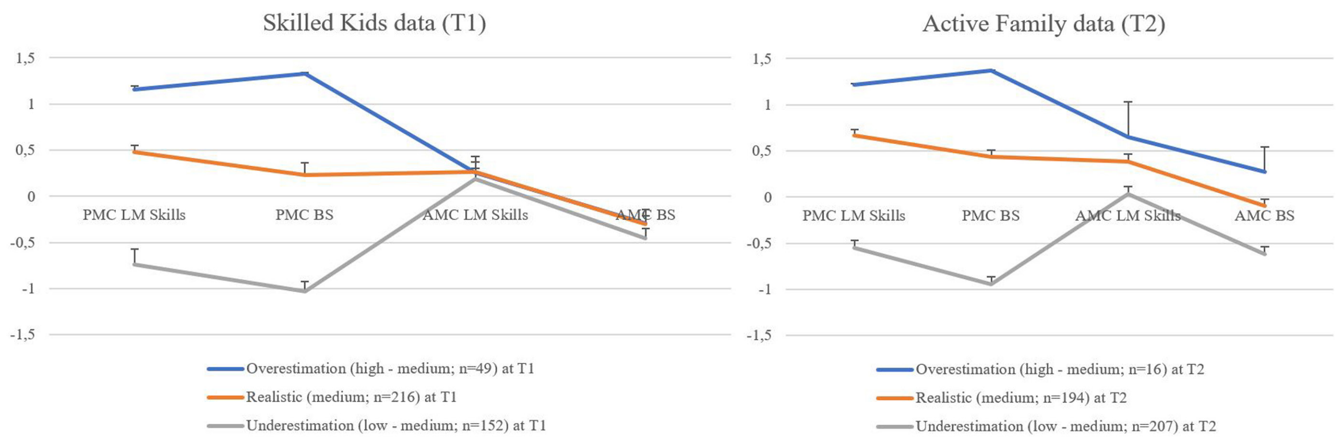

FIGURE 2 Perceived motor competence (PMC) and actual motor competence (AMC) latent class mean profiles for locomotor (LM) and ball skills (BS) at time 1 (T1, early childhood) and at time 2 (T2, middle childhood) for girls.

overestimation ($p < 0.001$ and $p < 0.001$, respectively) profiles. Similarly, girls with an underestimation profile at T1, had significantly lower actual locomotor and ball skills at T2, compared with girls in the realistic (medium; $p < 0.001$ and $p < 0.001$, respectively) and overestimation ($p < 0.001$ and $p = 0.002$, respectively) profiles. See Table 5.

4 | DISCUSSION

The present study extended previous longitudinal research on children's PMC-AMC profiles using data at two different time points to analyze, firstly, if different PMC-AMC profiles could be traceable in early and middle childhood, and secondly, to describe transitions between the profiles

TABLE 4 Transition probabilities between time 1 (T1) and time 2 (T2) for boys and girls.

	n	Realistic (low) at T2 (*n* = 162)	Realistic (medium) at T2 (*n* = 194)	Overestimation (high–medium) at T2 (*n* = 61)	Underestimation (low–medium) at T2 (*n* = 207)	Realistic (medium) at T2 (*n* = 194)	Overestimation (high–medium) at T2 (*n* = 16)
Boys							
Realistic (low) at T1	115	0.922	0.000	0.078			
Realistic (medium) at T1	190	0.133	0.714	0.153			
Overestimation (high–medium) at T1	116	0.276	0.514	0.209			
Girls							
Underestimation (low–medium) at T1	152				0.925	0.074	0.001
Realistic (medium) at T1	216				0.236	0.691	0.073
Overestimation (high–medium) at T1	49				0.323	0.677	0.000

Note: *N* is the number of children in the profile.

across time. Lastly, we investigated how the PMC-AMC profile in early childhood differed in their mean values of AMC and PMC variables in middle childhood. The findings showed that divergent PMC-AMC profiles could be identified, and that these varied based on the gender of the child. More importantly, PMC-AMC profiles in early childhood predicted the PMC-AMC profile, as well as the AMC and PMC level as individual variables, in middle childhood for both genders, especially if the profile had a low level of PMC. Within the transitions, there were generally more transitions from overestimates to realistic PMC-AMC profiles. These results are a valuable addition to the growing PMC-AMC research as it gives an insight into the development of PMC in relation to AMC from early to middle childhood in a follow-up study with nationally wide and extensive data using aligned measures between PMC and AMC.

Similar to several studies,[5,20,21] in the current study, profiles of PMC-AMC could be identified affirming the first aim of the authors. In total, three profiles were found for boys and girls in early and middle childhood. In boys, two realistic (medium and low) profiles were found, and additionally, a profile of overestimation. For girls, at both time points three profiles were found: realistic (medium), overestimation, and underestimation profiles. Even though past cross-sectional studies[5,12,20] have identified profiles without considering gender differences as suggested previously,[8] comparing the results of the current study to these past cross-sectional studies, some considerations can be still drawn. A few studies[5,8,12] in accordance with the current study, have found aligned low PMC-AMC profiles. In contrast to this study, those authors also found a high aligned (or realistic) profile. In the current study, no profile had high AMC, while several profiles had high PMC. This outcome of lack of high AMC in general is in line with several studies[13,22] that have reported low levels of AMC in children.

Few PMC-AMC studies have reported the mean values that represent the "high," "medium," and "low" profiles.[20,21] In one study,[20] researchers used cut-offs, such as <1SD from regression-predicted values to classify realists, >1SD to classify underestimators, and overestimators of their AMC depending on whether they were >1SD below or above the predicted values. In another study,[21] researchers identified three profiles based on age- and gender-adjusted PMC and AMC z-scores: low $z \leq -1.5$, medium $z = -1.49$ to 1.24, and high $z => 1.25$. As such a precise information was not available from the other profile studies,[5,8,12] it remains unknown if this lack of high AMC in the current study was due to divergent interpretation of the cut-off points or lower level of AMC. In addition, these profiles are always data-specific, and results cannot be generalized to other samples. Therefore, the high level

TABLE 5 Mean values, standard errors, and comparison of actual motor competence (AMC) and perceived motor competence (PMC) variables at time point 2 (T2) based on PMC-AMC profiles at time point 1 (T1) for boys and girls.

	1. Realistic (low)	2. Realistic (medium)	3. Overestimation (high–medium)	Overall test	Pairwise tests
Variables at T2	**M (SE)**	**M (SE)**	**M (SE)**	***p*-Value**	**$p < 0.01$**
Boys					
PMC LM	−0.72 (0.17)	0.10 (0.13)	0.22 (0.16)	<0.001	1 < 2,3
PMC BS	−0.35 (0.17)	0.52 (0.11)	0.56 (0.15)	<0.001	1 < 2,3
AMC LM	−1.26 (0.17)	0.27 (0.13)	−0.05 (0.18)	<0.001	1 < 2,3
AMC BS	−0.48 (0.20)	0.72 (0.13)	0.37 (0.18)	<0.001	1 < 2,3
	1. Underestimation (low–medium)	**2. Realistic (medium)**	**3. Overestimation (high–medium)**	**Overall test**	**Pairwise tests**
Variables at T2	**M (SE)**	**M (SE)**	**M (SE)**	***p*-Value**	**$p < 0.01$**
Girls					
PMC LM	−0.55 (0.13)	0.40 (0.12)	0.25 (0.17)	<0.001	1 < 2,3
PMC BS	−0.83 (0.12)	0.00 (0.13)	−0.07 (0.21)	<0.001	1 < 2,3
AMC LM	−0.11 (0.12)	0.47 (0.09)	0.19 (0.22)	0.003	1 < 2
AMC BS	−0.67 (0.13)	−0.35 (0.14)	−0.42 (0.16)	0.268	

Note: Mean differences between latent profiles were tested using the BCH test implemented in Mplus.

Abbreviations: AMC, actual motor competence; BS, ball skills; LM, locomotor skills; M, mean; PMC, perceived motor competence; SE, standard error.

of AMC in other profile studies may be also a result of larger AMC variation between the participants.

In this study, boys had more variation in their AMC levels, while girls' AMC levels were more consistent throughout the profiles. In general, the lack of variance in AMC in both genders may represent overall more mature AMC development. Indeed, an earlier comparative cross-national study[36] showed that Finnish children had better AMC compared with children from Belgium and Portugal. The researchers reflected that these AMC differences may be a result of the divergent roles of active play, transportation, community, and built environment, as well as government strategies and investment for PA in the everyday life of the children.[36] In short, in Finland, there is a strong culture of active play outdoors, as well as physically active transportation. Also, the surroundings are considered safe. Such opportunities to participate in PA may contribute to overall higher levels of AMC and less variability in the relationship between AMC and PMC.

The main finding, though, was that there existed gender differences in PMC-AMC profiles and in the transitions between the profiles. A previous longitudinal study[8] showed that a consistent number of profiles were found for boys and girls when locomotor and ball skills were considered separately instead of considering only the total sum scores of PMC and AMC. In the current study, in boys, the overestimation profile was larger in both time points while in girls, only a handful of children had high PMC and belonged to the overestimation profile. Similar to these findings, in the past, one study[20] found that most girls underestimated, and most boys overestimated themselves in ball skills. The same tendency of girls underestimating their AMC was demonstrated in a study by Van Veen et al.,[37] where girls outperformed boys in actual locomotor skills; however, girls did not perceive themselves to be better than boys. Thus, also in the current study, it may be that boys tended to overestimate their AMC more often leading to higher PMC.

Not only did boys tend to have higher PMC, but they also had a more realistic PMC-AMC profile as two of three profiles in boys were realistic profiles (low and medium) while in girls, there was only one realistic (medium) profile. This finding is in line with a past study[18] that found gender differences in the accuracy of ability judgments. In their study, boys displayed a higher level of accuracy than girls. Also, boys tended to use divergent criteria to judge their competence than girls. They also showed that more realistic children demonstrated a higher dependency on the use of peer comparison and evaluation, while children with less realistic evaluations placed more importance on feedback from significant adults,[18] such as parents, teachers, and coaches. As the study[18] demonstrated that boys tended to prefer more external feedback (game outcome/ease of learning new skills), it may be that these differences in sources of information develop PMC differently between the genders. Additionally, it is also suggested that these gender differences in PMC could be attributed to AMC gender differences, as boys are often reported to have better ball skills[10,38,39] while locomotor skills are less distinctive.[10] These gender differences in AMC have been previously explained due to different physical activities,[39] such as different content of hobbies,[39] as well as differences in some environmental and sociocultural factors[38] or stereotypes.[40] Yet, a recent systematic review and meta-analysis examining the relationship between AMC and PMC[19] summarized that there were no gender differences in the relationship between PMC and AMC. The authors[19] reflected that the young age of the children (60% of the participants were under 12 years) may explain the result. To summarize, there seems to be accordance, or at least a strong hypothesis, that ability to evaluate skills can be age dependent[2,3,14,18] while findings related to gender differences seem to be typical, yet, at times inconsistent.[19]

Based on the transitions between the profiles from early to middle childhood, and to respond to the second aim of the study, the PMC-AMC profiles in early childhood predicted PMC-AMC profiles in middle childhood in both genders, especially if the level of PMC was low. Additionally, the transitions from the overestimation profiles into realistic or underestimation profiles were abundant as most of the overestimators at T1 were realistic (medium; 68% of the girls and 51% of the boys), realistic (low; 28% of the boys) or underestimators (32% of the girls) at T2. In general, this tendency to drop the level of PMC from early to middle childhood was expected due to changes in a child's cognitive capacity, which permits the child on the one hand to understand more abstract concepts,[14] and on the other hand, to use different sources of information.[15,18,19] However, this decline, seems to be more evident in girls rather than in boys. Many reasons may explain this result; firstly, socialization may play an important role in gender differences leading to differences in PMC development as girls and boys may be treated differently.[19] Also, one study[41] affirmed gender differences in brain development, which could potentially reflect cognitive development in children. However, the authors underlined most differences in brain structure and cognitive development were individually based, and that gender explained a minority of these differences.[41] In essence, it remains for future studies to explain why the decline of PMC is more evident in girls rather than boys.[8]

Finally, to respond to the third aim of the study, it seems that regardless of the gender of the child, those children who have low PMC in early childhood, are at risk of not experiencing the development of their PMC and AMC in the near future. In the past, there has been uncertainty whether a high PMC in early childhood would better foster children's positive spiral of engagement towards a physically active lifestyle, compared with a positive, yet realistic PMC. For example, one past study[20] stated that overestimation of AMC may lead to higher PA, but a more recent study reported that the most effective manner to support child's PMC-AMC development is to have both high and aligned values of PMC and AMC.[8] Our study supports this latter finding, as it was less important whether PMC was high or realistic (medium) to subsequent AMC compared with simply possessing low PMC in early childhood. This is because the present study showed that lower PMC in early childhood predicted lower AMC and PMC in middle childhood. More precisely, for boys, children in the realistic (medium) profile in early childhood had the highest AMC also in middle childhood. For girls, children in the realistic (medium) profile in early childhood tended to have higher actual locomotor skills in middle childhood compared with children in the underestimation profile. Secondly, the study showed that low PMC in early childhood tends to remain low compared with other profiles in middle childhood. Consequently, in future, it may be associated with a negative spiral of engagement between PA, AMC, and PMC.[3] Thus, we propose that what we should focus on is being able to recognize those children who have low PMC as soon as possible to avoid a potential negative spiral of engagement that may lead to less PA,[5,8] unhealthy body weight,[5,8] lower global self-worth[12] and less autonomous motivated for PA[6,8,12] regardless of the level of AMC. To do so, we must recognize firstly, the individual needs of children having low PMC, and secondly, gender-based needs. In girls, interventions should target on enhancing the PMC level to higher and more aligned in relation to AMC, as girls more likely underestimate their AMC.[20] Also, we should reduce the sociocultural stereotypes[40] that may still explain girls' lower PMC in general compared with boys. In boys, according to this study, fewer children had low PMC. However, in boys, the realistic (low) profile would need support for both PMC and AMC development, not only in enhancing the level of PMC.

This was one of the first studies analyzing not only the divergent profiles of PMC-AMC but also reporting the transitions over time and showing how the PMC-AMC profiles in early childhood predicted the AMC and PMC levels in middle childhood. Limitations include that during middle childhood, the shortened version of the TGMD-3 was used to optimize the data collection so that nearly 100 schools could be visited in the project time frame. There are also some methodological limitations that should be noted. TGMD-3 has been criticized due to its sport-specific characteristics and lack of balance skills. Also, in the scoring, ball skills (54 p.) have more points in relation to locomotor skills (46 p.), which may reflect the gender differences. In PMSC, to date, Finnish data-specific reliability scores have not been published. In data, due to the voluntary participation of the children and families, there was a bias within the participants towards more educated families and children. These families may also have a positive attitude towards PA as they voluntarily wanted to use their time in participating in time-consuming research. Finally, the major limitation of the study, similar to past studies that have used profile approach to PMC,[5,20,22] is that the results cannot be generalized to other samples as it reflects the data that are available in the phases of analysis. However, to conclude, the strengths of the study include the geographically randomized longitudinal study design with a wide sample of children in two divergent time points (early and middle childhood) providing novel data not only about the PMC-AMC profiles but also transitions from the profiles in time using latent profile analysis.

5 | CONCLUSIONS

This follow-up study supports the idea that there are differences in PMC-AMC profiles between the genders[8] and therefore, profiles were gender-specific. The study revealed three profiles in relation to PMC and AMC in boys and girls in two time points (early and middle childhood). Based on the transitions between the profiles from early to middle childhood, it seems that PMC-AMC profile in early childhood tended to predict the PMC-AMC profile in middle childhood in both genders, especially if the profile had low PMC in girls or realistic (low) PMC in boys. Also, if a child had low PMC profile in early childhood, the AMC and PMC variables tended to be low also in middle childhood. As low PMC tends to remain from early to middle childhood, it is recommended that parents and professionals put a great effort to foster a child's PMC in early childhood. A special effort should be put in firstly, for girls to avoid underestimation of their AMC, and secondly, for boys in realistic (low) profile to support and enhance simultaneously their PMC and AMC development.

6 | PERSPECTIVE

In the past, there has been a theoretical consensus that from early childhood to middle childhood, the children tend to have a declining PMC.[3,14,15] This follow-up study supported the previous research as it found that there was a decline in children's PMC across time; however, these temporal changes in PMC varied based on gender and the PMC-AMC profile of the child. In general, boys had more variation in the PMC-AMC profiles. Previously,[15] it has been questioned if a higher PMC rather than a more realistic PMC in early childhood enhances more child's future PMC and AMC. According to this study, it seems that both enhance PMC and AMC in middle childhood. However, the children with low PMC are most at risk of not developing accurate, yet positive PMC and AMC in middle childhood. Therefore, we suggest targeting interventions especially to children, who have low PMC in early childhood. Finally, as gender differences occurred, adults should enhance equal opportunities for girls and boys to improve their perceived AMC by enhancing children's possibilities to be physically active in different environments that enable versatile PA. At its best, increased PA may favor children's AMC and PMC development from early to middle childhood.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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