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To cite this article: Isaac Estevan, Xavier García-Massó, Javier Molina García & Lisa M. Barnett (2019) Identifying profiles of children at risk of being less physically active: an exploratory study using a self-organised map approach for motor competence, Journal of Sports Sciences, 37:12, 1356-1364, DOI: [10.1080/02640414.2018.1559491](https://doi.org/10.1080/02640414.2018.1559491)

To link to this article: <https://doi.org/10.1080/02640414.2018.1559491>

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Identifying profiles of children at risk of being less physically active: an exploratory study using a self-organised map approach for motor competence

Isaac Estevan ^a, Xavier García-Massó^b, Javier Molina García^a and Lisa M. Barnett ^c

^aAFIPS Research Group. Department of Teaching of Music, Visual and Corporal Expression, University of Valencia, Valencia, Spain; ^bHUMAG Research Group. Department of Teaching of Music, Visual and Corporal Expression, University of Valencia, Valencia, Spain; ^cInstitute of Physical Activity and Nutrition. School of Health and Social Development, Deakin University, Geelong, VIC, Australia

ABSTRACT

This study aims to develop profiles in children according to physical fitness, actual and perceived motor competence, and to examine the level of engagement in physical activity and weight status according to these profiles. In the study, 156 typically developing Spanish children (47.4% girls) of primary school age (5–11 years-old) participated voluntarily. Children's perceived and actual motor competence, physical fitness, physical activity participation and weight status were assessed. A Self-Organising Map and *K*-means cluster analysis were used to classify and visualise the values. Four profiles were found: profile 2 was aligned – high capacity, high perception, profile 1 was partially aligned – medium capacity and perception, profile 3 and 4 were both non-aligned – low capacity, medium perception and medium capacity, low perception; respectively. Children in profile 2 were more active than children in profile 3 and 4 ($P < .05$). In profile 2 there was a lower frequency of overweight/obese children than normal-weight children. On the contrary, in profiles 1, 3 and 4 a similar distribution of normal-weight and overweight/obese children was found. High capable children with high perception exhibited higher physical activity participation and were more likely to be of normal-weight compared to those with low capacity and/or perception.

ARTICLE HISTORY

Accepted 8 October 2018

KEYWORDS

Motor development; children; perception; physical capacity; self-organised maps

Introduction

Child obesity has increased considerably in developed countries over recent decades (Lobstein et al., 2015) with 16–26% of children aged 6–13 years being obese or overweight in Spain (Gutiérrez, Aldea, Cavia, & Alonso-Torre, 2015). In addition, internationally, the majority of children fail to meet current physical activity (PA) recommendations of at least 60 minutes of daily moderate-to-vigorous PA (Currie et al., 2012). In this regard, 48% of Spanish children are not meeting these recommendations (Mielgo-Ayuso et al., 2016). The identification of groups of children (e.g., low parental education or household income, girls in comparison to boys, etc.) who are at risk of being physically inactive and obese is of key importance.

A model of motor development (Robinson et al., 2015; Stodden et al., 2008) postulates the existence of a dynamic and synergistic role between actual motor competence (MC), perceived MC and/or physical fitness as contributors which may produce a positive or negative spiral impacting on children's health. These factors can positively contribute to engagement in PA (Van Capelle, Broderick, van Doorn, Ward, R., & Parmenter, 2017) and improved weight status (WS) (Barnett et al., 2016a; Lima et al., 2017; Tompsett, Sanders, Taylor, & Cogley, 2017) across childhood into adolescence and adulthood (Barnett, Van Beurden, Morgan, Brooks, & Beard, 2008b; Khodaverdi, Bahram, Stodden, & Kazemnejad, 2016; Lima et al., 2017). Conversely, in this model, low levels of actual

MC, perceived MC, and physical fitness are seen as a barrier for PA participation and a stimuli for obesity in children (Lima et al., 2017; Stodden et al., 2008; Tompsett et al., 2017). Thus, “physical capacity” (in this paper defined as actual MC and physical fitness), perceived MC and behavioural factors (PA participation) are linked (Khodaverdi et al., 2016).

From a health perspective, to address associations between these variables in the model of motor development (Robinson et al., 2015; Stodden et al., 2008), children's physical capacity and perception have mainly been studied from a variable-centred approach (Jekauc, Wagner, Herrmann, Hegazy, & Woll, 2017; Khodaverdi et al., 2016). From this approach it is hard to uncover the optimal combination of physical capacity and perception (Estevan & Barnett, 2018). As a result, in children with divergent levels of actual and perceived MC this approach has limited insights (Bardid et al., 2016). Recently, a person-centred approach addressing differences among children and adolescents by identifying groups who function in a similar way according to, for instance, perception and actual MC has emerged (Bardid et al., 2016; De Meester et al., 2016; Masci, Schmidt, Marchetti, Vannozzi, & Pesce, 2018; Utesch, Dreiskämper, Naul, & Geukes, 2018). These studies provided evidence of different profiles according to the level of perceived and actual MC with implications for the level of PA participation (Estevan & Barnett, 2018). In this line, children with low perceived MC seem to be less autonomously

motivated for sports and have a lower global self-worth (i.e., general value of oneself) than children with high perceived MC, even if they have high MC (Bardid et al., 2016). Children who overestimate their actual MC appear to be involved in more sport participation (Masci et al., 2018). Accordingly, it is important to understand how children's self-perception of their MC relates to unhealthy WS because it is an appropriate way to counteract the early onset of obesity (De Meester et al., 2016; Utesch et al., 2018). No study, to the authors' knowledge, using a person-centred approach, has established profiles using physical fitness in addition to actual and perceived MC, even though physical fitness is important to consider.

This paper seeks to understand whether a child's physical capacity and perception affects his/her PA behaviour and WS. Considering physical capacity has a longitudinal impact on WS (Lima et al., 2017), and that WS and PA can differ according to sex (Fairclough, Boddy, Ridgers, Stratton, & Cumming, 2011; Gutiérrez et al., 2015), children's sex is important to consider in profile development (Masci et al., 2018). Moreover, perceived MC varies according to children's age and sex (Estevan et al., 2018b). Thus, the current study has three aims, 1) to develop profiles in children according to physical fitness, actual and perceived MC, 2) to analyse the profiles considering children's age and sex, and 3) to examine the level of engagement in PA and WS according to these profiles. Using non-supervised classification techniques [e.g., Self-Organised Maps (SOM)], to examine physical capacity and perceived MC could generate additional insights.

Methods

Participants

A cross-sectional design was used to study 156 typically developed Spanish children (47.4% girls) from 5 to 11 years old [age: 7.98 years, SD = 1.42, weight: 30.90 kg, SD = 10.36, height: 1.30 m, SD = 0.12 and body mass index (percentage value): 66.59th, SD = 29.72]. Participants were recruited (consent rate of 81.4%) by convenience from six (three public and three private) primary schools. Data was obtained from the first year of a longitudinal study in which children aged 3–11 years-old at baseline were examined three times in a period of three years; these data were also utilised for manuscripts which focused on the validation of the scales used (Estevan et al., 2017). Parental or guardian consent to participate in the study was obtained. Approval was also obtained from The Institutional Review Board of the University (H1446557620395).

Procedure and instruments

Children's perceived and actual MC, physical fitness (measured by leg power), PA participation and WS were assessed (February–April 2016) in a single session (45 min per child approximately) in their respective school. Actual MC was assessed after the other measures.

To assess *children's perceived MC*, the pictorial scale of Perceived Movement Skill Competence (Barnett, Ridgers, Zask, & Salmon, 2015; Barnett et al., 2016b), Spanish version (Estevan et al., 2018a) was used with each child. This scale is composed

of twelve pictographic tasks; matched to the skills in the Test of Gross Motor Development second edition (TGMD-2), i.e., locomotion (run, gallop, hop, leap, jump forward, and slide) and object control skills (overarm throw, catch, roll, strike with two hands, bounce and kick a ball). The administration was carried out according to the protocol of the original scale (Barnett et al., 2016b). That is, the perceived MC for each skill was rated on a 4-point scale (with a higher score indicating high perceived competence) using a dichotomy two staged process, i.e., two questions with two options each to choose. Children were instructed to choose which picture they felt looked like them; then for their chosen picture they were asked to rate their perceived competence between two new options (i.e., "really good"–"pretty good" or "sort of good"–"not too good"). The range of scores for the total scale was 12–48, with subscales ranging from 6–24 (i.e., locomotion & object control). This scale has acceptable internal consistency and test-retest reliability for Spanish children (Estevan et al., 2018a). In the current sample, the internal consistency of the twelve items measured by the ordinal alpha was .70.

Children's actual MC was assessed by using the TGMD third edition (TGMD-3) Spanish validated version (Estevan et al., 2017) in a large sports hall by two trained research assistants. Each child was given a videotape and/or practical demonstration by a research assistant of each skill, one practice attempt and two assessment trials for each skill. Each task was video recorded to allow for subsequent coding. Each participant completed all 13 skills that conform to the TGMD-3 (i.e., for locomotion: run, gallop, skip, hop, slide, and jump forward and object control or manipulative skills: overarm throw, underarm throw, catch, strike with two hands, strike with one hand, bounce, and kick a ball). For each skill, task components were marked as "present" = 1 (child performed the correspondent component consistently) or "absent" = 0 (the child did not). The sum of each skill informs the total score with a range for the scale of 0–100. This test has excellent internal consistency in children (Estevan et al., 2017). For the two raters involved in the study, the intra-class correlation coefficient based on the total scores (13 skills of the TGMD-3) of 20 children's videos selected randomly, showed excellent intra-rater (.98, 95% CI .97–.99) and inter-rater (.90, 95% CI .80–.94) reliability (Estevan et al., 2017).

Physical fitness was assessed individually by leg power during the TGMD-3, with the relative distance score in the standing long-jump test (standardised according to the participant's height) (Ruiz et al., 2011). Each child performed the standing long-jump twice, but only the maximum distance (cm) of the long-jump was recorded (Jekauc et al., 2017). Distance assessment was conducted by a research assistant as the orthogonal distance (cm) between the onset line and the child's closest heel.

Self-reported PA behaviour was assessed by using the Spanish version adapted for children of the Physical Activity Questionnaire for Children (Kowalski, Crocker, & Donen, 2004; Martínez-Gómez et al., 2009). This 7-day recall instrument provides PA information during a primary school week (Fairclough et al., 2011). In the current study each participant answered the 10 items in a single survey. The first 9 items are in a Likert style from 1 (e.g., none) to 5 (e.g., 7 or more times), with a higher score indicating high PA participation; with

a total relative score ranging from 1 to 5. The internal consistency for all items measured by Cronbach's α was .74.

Children's WS was measured by the body mass index (BMI), assessing the children's height (m) and the body mass (kg) using a standard stadiometer scale and a bioelectrical impedance scale (Tanita BC-601). BMI percentiles (Kuczmarski et al., 2002) were used to classify children's WS in accordance with their sex and age as follows: normal-weight (<85th percentile) and overweight/obese ($\geq$ 85th percentile).

Analytical methods

To answer research questions 1 and 2, SOM analysis was used to classify participants, visualise the input variables values, and provide profiles by their similarities in terms of perceived and actual MC and physical fitness (Pellicer-Chenoll et al., 2015). SOM was computed with Matlab R2008a (Mathworks Inc., Natick, USA) and the SOM toolbox for Matlab (Vesanto, Himberg, Alhoniemi, & Parhankangas, 1999). This analysis tool has been applied previously in disciplines such as Biology, Geography, Medicine, Education and Chemistry (Astel, Tsakovski, Barbieri, & Simeonov, 2007; Chen, Chang, & Huang, 2000; Mele & Crowley, 2008; Rosado-Muñoz, Martínez-Martínez, Escandell-Montero, & Soria-Olivas, 2013; Tamayo et al., 1999; Thuneberg & Hotulainen, 2006).

The procedure used to obtain a SOM can be explained in three phases (Pellicer-Chenoll et al., 2015): network building, initialisation and training. The first phase was the construction of a neuron network. For that, a lattice size is selected depending on sample size (i.e., 9×7 neurons in our study). Thus, the neural network was a set of neurons of hexagonal shape ordered into the form of a net. Each neuron is represented by a value for each input variable (i.e., perceived MC, actual MC and physical fitness). In the second phase (the initialisation), a value or weight was assigned for each input variable to each of the neurons in two different ways: randomised and linear initialisation (Pellicer-Chenoll et al., 2015). In the third phase (the training), a process to modify the initially assigned weights or values of the neurons was conducted (two different training algorithms were applied in this study: sequential and batch) (Oliver et al., 2016). Overall, training is an iterative process in which neuron weights are modified. The modification of the neuronal weights in each iteration depends on several factors. First of all, an input vector (i.e., a case or subject of the study) is presented to the network. Then, the neurons in the lattice "compete" (i.e., compare the Euclidian distance of their weight vector and the case values) to win the input vectors. The winning neuron is the one that achieves the smallest Euclidean distance between its weight vector and the input vector, so that the weight vector of the winning neuron has the closest values to the input vector values. All the neurons in the lattice then adapt their weight values closer to the values of the input case. The magnitude of the adaptation depends on the learning ratio and the neighbor function. The learning ratio has a high value during the beginning of the training process and is gradually reduced as the training process goes on and the neighbor function maximises the adaptation of the winning neuron. The rest of the neurons also adapt their weights according to this function; the further the neuron is from the winner, the smaller the adaptation

magnitude. This process is repeated until the training process ends (Pellicer-Chenoll et al., 2015).

Due to random processes included in SOM analysis, this process was repeated 100 times so that the odds of finding the best solution to the problem increased (Rosado-Muñoz et al., 2013). As a result of the two different training methods, four neighbourhood functions and two initialisation methods, 1600 SOM were obtained (i.e., $100 \times 2 \times 4 \times 2$). The map with the minimum error when multiplying the quantization and topographical errors was selected (Pellicer-Chenoll et al., 2015).

After the SOM analysis, a *k-means* method was used to classify the neurons in greater groups according to their characteristics. The number of clusters was chosen to range between 1 and 5 to avoid an excessive number of profiles. Following Figure 1, the number of clusters showing a quantization error of around .8 was four and the number of subjects allocated in each cluster was more than twenty. The quantization error expresses the accuracy of the value assigned to the centroid of the cluster regarding the values of each participant included in that cluster (Pellicer-Chenoll et al., 2015). The SOM analysis was conducted three more times by i) including the children's specific age as an input factor (Figure 2) and ii) for boys (Figure 3) and iii) for girls (Figure 4). Diverse profiles (i.e., aligned, aligned partially or not aligned) were found. According to the relative level of values in the input variables (physical fitness, actual and perceived MC), they were termed as low, medium or high values.

Statistical analyses

To answer research question 3, i.e., to examine how these cluster profiles relate to PA and WS, statistical analyses were carried out using SPSS 23.0 (SPSS Inc., Chicago, IL). Kruskal-Wallis tests were applied to compare PA participation according to the cluster. The effect size was calculated (*r* value) with values below .3, .3–.5 and above .5, considered to have small, moderate, and large effects, respectively (Field, 2009). Lastly, Chi-Square (χ^2) tests were applied to determine the existence of an association within a particular cluster between the frequency of normal-weight and overweight/obese children. The strength of the associations was measured by Cramer's *V* with values between .1–.35, .36–.49 and above .5, considered to have small, moderate, and large associations, respectively (Field, 2009). The level of significance was set at $p \leq .05$.

Results

The quantification error suggested the existence of four clusters (Figure 1(b,c)). The four profiles were characterised (Table 1) as follows: Profile 1 (*Aligned partially – Medium*) showed medium values in physical fitness, high-medium values in actual MC and medium values in perceived MC. Profile 2 (*Aligned – High*) showed high values in physical capacity and perception. Profile 3 (*Non-Aligned – Low Capacity, Medium Perception*) was characterised by low values in physical capacity and medium values in perceived MC. Profile 4 (*Non-Aligned – Medium Capacity, Low Perception*) showed medium values in physical capacity and low in perceived MC.

There was a main effect of cluster on PA participation ($H_3 = 16.28$; $P = .001$), physical fitness ($H_3 = 66.86$; $P < .001$),

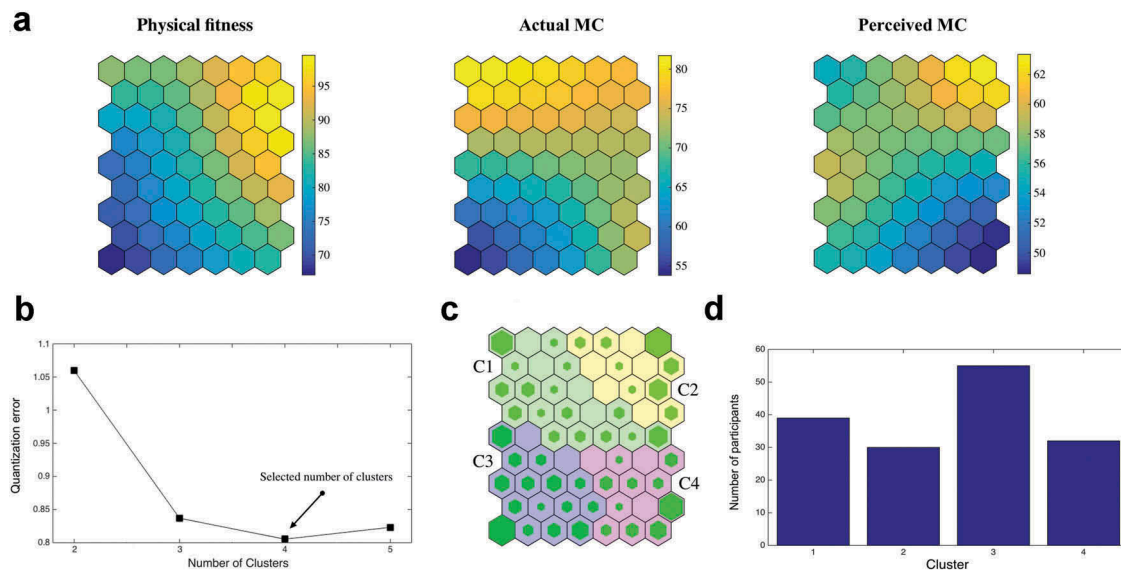


Figure 1. Component planes of the input variables. On the top from the left to the right side, a) component planes of physical capacity [i.e., physical fitness (%) and actual motor competence (MC)] and perceived MC. On the bottom, from the left to the right side, b) criteria used to select the number of cluster in the k-means analysis by using the quantization error; c) hit map where the four clusters/profiles (c1-c4) are marked (in every neuron, the bigger the green shadow the higher the amount of children included); d) sample distribution in every cluster/profile.

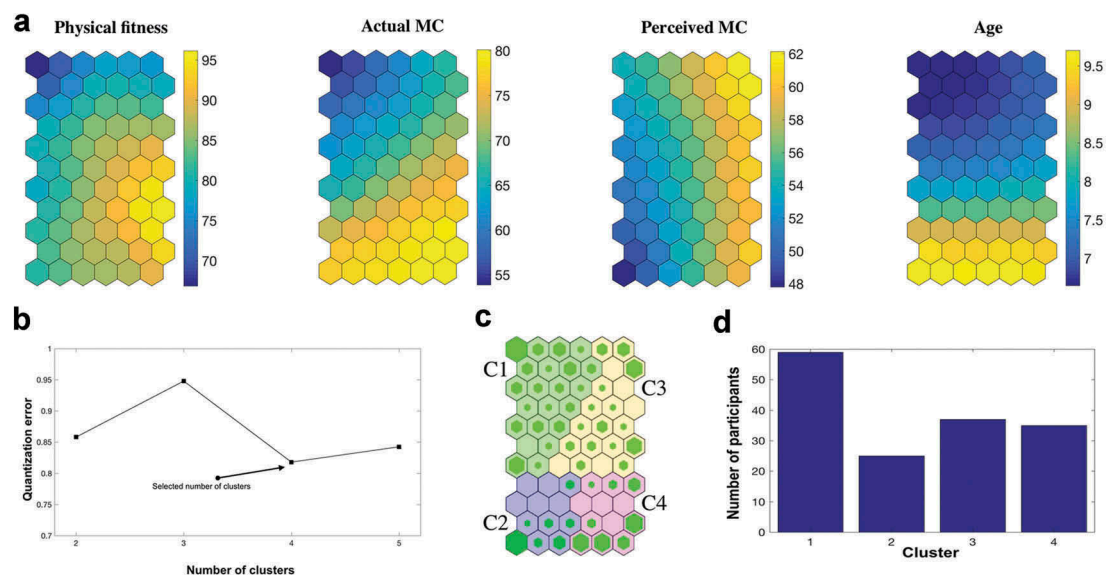


Figure 2. Component planes of the input variables including the age. On the top from the left to the right side, a) component planes of physical capacity [i.e., physical fitness (%) and actual motor competence (MC)], perceived MC and age (years). On the bottom, from the left to the right side, b) criteria used to select the number of cluster in the k-means analysis by using the quantization error; c) hit map where the four clusters/profiles (c1-c4) are marked (in every neuron, the bigger the green shadow the higher the amount of children included); d) sample distribution in every cluster/profile.

actual MC ($H_3 = 91.75$; $P < .001$) and perceived MC ($H_3 = 90.49$; $P < .001$). Regarding PA, pairwise comparisons showed that children in profile 2 (*Aligned – High*) were more active than children in profile 3 (*Non-Aligned – Low Capacity, Medium Perception*) ($z = 3.62$; $r = .39$; $P = .002$) and profile 4 (*Non-Aligned – Medium Capacity, Low Perception*) ($z = 3.54$; $r = .45$; $P = .002$).

Also in Table 1 a significant association between cluster and WS is showed ($\chi^2_3 = 12.38$; $P = .006$). In profile 2 (*Aligned – High*) there was a lower frequency of overweight/obese children ($V = .28$). In profiles 1, 3 and 4 a similar distribution of normal-weight and overweight/obese children was found.

When children's age was included in the SOM analysis as an input variable, the quantification error suggested the existence of almost the same four clusters (Figure 2 and Table S.1). There was a main effect of cluster on PA participation ($H_3 = 11.20$; $P = .011$); pairwise comparisons showed that older children in profile 4 (*Aligned-high*) were more active than younger children in profile 1 (*Non-aligned low capacity, medium perception*) ($z = 2.97$; $r = .31$; $P = .002$).

When the SOM analysis was conducted for boys and girls separately, the quantification error suggested the existence of five clusters for both, boys (Figure 3 and Table S.2) and girls (Figure 4 and Table S.3). For boys, a main effect of cluster on

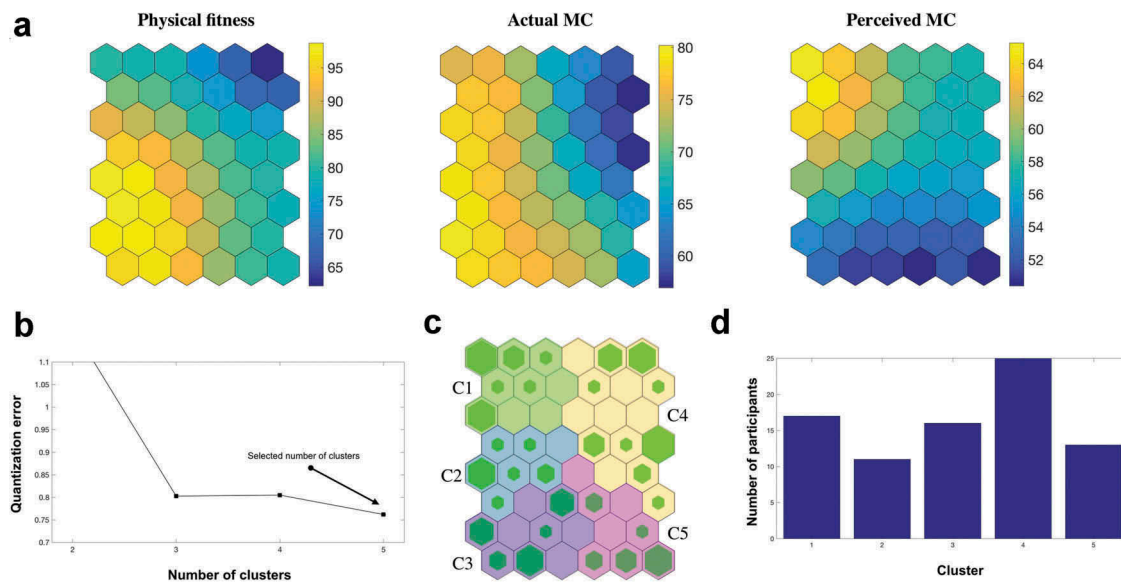


Figure 3. Component planes of the input variables for boys. On the top from the left to the right side, a) component planes of physical capacity [i.e., physical fitness (%) and actual motor competence (MC)] and perceived MC. On the bottom, from the left to the right side, b) criteria used to select the number of cluster in the k-means analysis by using the quantization error; c) hit map where the five clusters/profiles (c1-c5) are marked (in every neuron, the bigger the green shadow the higher the amount of children included); d) sample distribution in every cluster/profile.

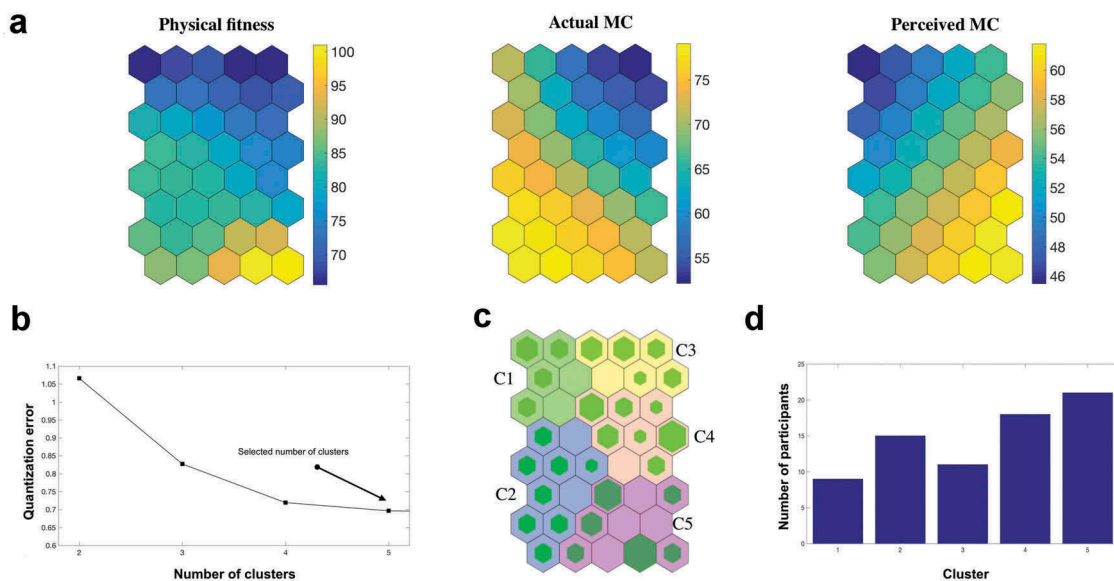


Figure 4. Component planes of the input variables for girls. On the top from the left to the right side, a) component planes of physical capacity [i.e., physical fitness (%) and actual motor competence (MC)] and perceived MC. On the bottom, from the left to the right side, b) criteria used to select the number of cluster in the k-means analysis by using the quantization error; c) hit map where the five clusters/profiles (c1-c5) are marked (in every neuron, the bigger the green shadow the higher the amount of children included); d) sample distribution in every cluster/profile.

PA participation ($H_4 = 12.41$; $P = .014$) was found; pairwise comparisons showed that boys in profile 2 (*Non-Aligned – High Capacity, Medium Perception*) and 3 (*Non-Aligned – High Capacity, Low Perception*) reported higher PA participation than boys in profile 4 (*Non-Aligned – Low Capacity, Medium Perception*) ($z = 2.78$; $r = .54$; $P = .054$ and $z = 2.81$; $r = .44$; $P = .050$, respectively). For girls, no effect of cluster was found ($P > .05$).

Discussion

This study aimed to examine profiles in children according to physical fitness, actual and perceived MC. Perceived MC is

highlighted as a relevant mediator between actual MC and PA engagement (Jeka et al., 2017; Utesch et al., 2018) thus, understanding the role of perceived MC in children and how it relates to physical capacity may provide an insight into children's behaviour. The current study complements previous literature in the analysis of profiles of MC (Bardid et al., 2016; De Meester et al., 2016; Masci et al., 2018) in children and adolescents (between 7 and 13 years-old) wherein according to actual and perceived MC [assessed by using heterogeneous test (e.g., Körperkoordinations test für Kinder or TGMD) and scales (e.g., Self-Perception Profile for Children or PMSC), respectively], profiles were defined as “accurate” or “overestimated”. Since our study analysed not

Table 1. Descriptive values according to the profile.

	Profile 1 (Aligned partially – Medium) (n = 39)	Profile 2 (Aligned – High) (n = 30)	Profile 3 (Non-Aligned – Low Capacity, Medium Perception) (n = 55)	Profile 4 (Non-Aligned – Medium Capacity, Low Perception) (n = 32)
	Mean ± SD [95% CI]	Mean ± SD [95% CI]	Mean ± SD [95% CI]	Mean ± SD [95% CI]
Perceived MC	56.28 ^{†‡} ± 2.65 [55.45–57.11]	62.77 [‡] ± 3.97 [61.35–64.19]	56.35 ^{†‡} ± 4.74 [55.10–57.60]	48.13 ± 3.89 [46.78–49.48]
Actual MC	76.64* ± 7.07 [74.42–78.86]	77.63* ± 6.88 [75.17–80.09]	57.78 ± 7.45 [55.81–59.75]	72.63* ± 9.13 [69.47–75.79]
Physical Fitness	84.71* [†] ± 11.18 [81.20–88.22]	98.79* ± 11.27 [94.76–102.83]	71.03 ± 11.97 [67.86–74.19]	85.04* [†] ± 13.10 [80.50–89.58]
Self-reported PA	2.78 ± 0.51 [2.62–2.94]	3.22 ± 0.71 [2.97–3.47]	2.67 [†] ± 0.51 [2.54–2.80]	2.62 [†] ± 0.43 [2.47–2.77]
BMI percentile	69.44 ± 31.71 [59.49–79.39]	60.76 ± 26.11 [51.42–70.11]	70.84 ± 28.15 [63.40–78.28]	61.25 ± 32.60 [49.96–72.55]
Weight Status (NW/OW & O)	20/19	27/3 [‡]	32/23	19/13

Note. MC: motor competence. Physical fitness (normalised to the height expressed in percentile values). PA: physical activity. BMI percentile: body mass index (percentile values). Weight Status (NW/OW & O) is reported as Normal-weight/Overweight-obese. Mean ± Standard Deviation. 95% of confidence interval is reported between brackets. [†] significant differences with profile 2. * significant differences with profile 3. [‡] significant differences with profile 4. [‡] greater frequency of normal-weight than overweight-obese children in this profile.

only measured perceived and actual MC, but also physical fitness, we defined the possible profiles as “aligned”, “aligned partially” or “non-aligned”. Similar to two of the aforementioned studies (Bardid et al., 2016; De Meester, Maes, et al., 2016) (in samples of around 90–216 participants), four profiles were found (Figure 1(c)), one was *aligned – high* (profile 2) in terms of high physical capacity and perception. Another profile was *aligned partially* (profile 1) wherein children aligned perception with one of the physical capacity variables (physical fitness) and were almost aligned with relation to actual MC (Figure 1(a,c)). Two profiles were *non-aligned* and characterised by medium and low values in physical capacity and perception of MC (i.e., profiles 3 and 4). These results support the model of motor development put forward by Stodden et al. (2008), because children in profile 2 with both physical capacity and perception at high levels reported higher engagement in PA than children in profiles 3 and 4. Moreover, there was a higher frequency of normal weight children within profile 2.

Our finding appears to support Utesch et al. (2018) and De Meester et al. (2016) who found convergent high values in children (around 9 years-old) and adolescents’ (12.4–14.9 years-old) actual and perceived MC were associated with a higher motivation for sports and higher PA engagement. Even though the study by Bardid et al. (2016) (children aged 7.8–10.6 years-old) found that high values in perceived MC (independent of the value in actual MC) showed healthier behaviour than those without high values, longitudinal evidence indicates having perception aligned with actual values relates to PA engagement across time (Utesch et al., 2018). Taking into account that optimal levels of actual and perceived MC are key for engaging children in PA and sports (Bardid et al., 2016), and that the relationship between actual MC and fitness is dynamic and may change across childhood (Stodden, Gao, Goodway, & Langendorfer, 2014), this could be seen as indicative of the importance of intervention for enhancing the alignment of children’s perception of MC and their physical capacity (Utesch et al., 2018).

Children in profile 1 (*Aligned partially*) almost understood their own physical capacity which was at a medium level (Figure 1(a,c)). These children showed similar PA engagement to children in profile 2 (*Aligned – high*). However, in profile 1 (in

comparison to profile 2), the frequency of overweight/obese and normal weight children was similar. It is noted that as children age (from early childhood to late childhood or adolescence), self-perception may align with actual competence (Barnett, Morgan, van Beurden, & Beard, 2008a). Yet in the current study, those children who presented with high-medium levels of MC may not have similar perceptions because they slightly underestimated their actual MC. So, not having completely aligned results in physical capacity and perceived MC may be due to limited self-knowledge or a lack of adequate social comparisons. In our study this could be indicative of a high frequency of unhealthy WS in profiles 3 and 4. Furthermore, aligned profiles can help to prevent weight gain (De Meester et al., 2016; Utesch et al., 2018).

Our results suggest children with low and medium values in perceived MC that were not aligned with their physical capacity (profile 4 and 3, respectively), had lower PA engagement than those who were characterised as aligned – high. Systematic review evidence suggests a positive relationship between actual MC and PA in children (Barnett et al., 2016a), and the fact that the children who did not present high physical capacity values also reported lower PA participation supports these previous findings. Similarly, profiles 3 and 4 showed a similar frequency of children who were overweight/obese as compared to normal-weight. This is also in line with research which has found a positive relationship between FMS proficiency and healthier WS (Barnett et al., 2016a; Tompsett et al., 2017). It must be noted that the divergent profiles are related to a high frequency of overweight/obesity. It is suggested an early focus on instruction and improvement of MC might be a key component in both prevention and management of childhood overweight and obesity (D’Hondt et al., 2011; Utesch et al., 2018).

It is not a positive finding that more than the half of the sample in the current study (around 56 %) are classified in profiles 3 and 4 (Figure 1(d)); non-aligned profiles with low values in physical capacity and perception, respectively. This could mean that a large percentage of children in this study may be at risk of unhealthy lifestyles (Veldman, Jones, & Okely, 2016), and be less motivated for sport (Bardid et al., 2016). In line with Self-Determination Theory (Deci & Ryan, 2008),

a macrotheory applied to issues within a wide range of life domains, perceived competence is one of the three basic needs (i.e., autonomy, competence and relatedness) that influences self-regulated motivation. Those who perceived themselves as less competent are considered less autonomously motivated to participate in PA (De Meester et al., 2016). Thus, low levels of physical capacity and/or perceived MC can be associated with less PA and unhealthy WS in school-aged children (Van Capelle et al., 2017). Due to the prerequisite of MC in some physical activities, it seems there is a direct relationship between poor physical capacity and inactive behaviour, and consequently unhealthy WS (Lima et al., 2017).

When age was included as an input factor for the SOM analysis (Figure 2(a)) findings support previous results regarding the influence of age in physical capacity and perception (Barnett et al., 2008a; Stodden et al., 2014). That is, a tendency for there to be an association between perception and physical capacity in older children (profile 4) and an overestimation of physical capacity in younger children (profiles 1 & 3) (Figure 2(a,c) seems to exist (Estevan & Barnett, 2018; Harter, 1999). Particularly, four profiles were found, however, in comparison to the total sample the alignment between physical capacity and perception differed slightly. On the one hand, it is confirmed that the profile *aligned – high* (i.e., Figure 2(a,c) and Table S.1) corresponded to the older children from the sample under study (profile 4). Moreover, the profiles *non-aligned – medium capacity, high perception* and *non-aligned – low capacity, medium perception* involved the younger children (profiles 1 & 3, respectively). On the other hand, an alternative profile involving older children characterised by *non-aligned – medium-high capacity, low perception* (Figure 2(a,c)) appeared to complete the children's profiles. According to previous studies using a person-centred approach in the MC field (De Meester et al., 2016), children in profiles 4 and 3 could be seen as accurate and overestimate, respectively. This seems congruent with the fact of young children tend to overestimate their actual physical capacity, whereas older children are more capable of a realistic report (De Meester et al., 2016; Harter, 1999; Masci et al., 2018). Actually, older children in profile 4 (*aligned-high*) reported higher engagement in PA than younger children in profile 1 (*non-aligned – low competence, medium perception*) (Table S.1). This path of over- and underestimation of their actual physical capacity is also found in those “young” and “old” children in the rest of non-aligned profiles (i.e., profiles 1 and 2), perceiving themselves higher and lower than they actually are, respectively. Moreover, including age as a factor, meant the frequency of overweight/obese children in the profile *aligned-high* increased considerably from 11% to 52% of the children (Figure 2(d)), supporting the evidence of a high frequency of Spanish children being overweight as they age (Gutiérrez et al., 2015), despite high levels of physical capacity and perception. Nevertheless, considering evidence suggesting that overweight/obese-fit people have similar mortality risks as normal weight-fit people (Barry et al., 2014), research could focus on physical capacity interventions (i.e., physical fitness and actual motor competence) rather than on weight-loss interventions.

When the SOM analysis was conducted for boys and girls separately, the number of profiles increased to five profiles

(Figures 3 & 4). Also, the structure of the profiles changed i.e., more *non-aligned* profiles – mainly in boys – and more *aligned* profiles – in girls. For boys, four out of five profiles were classified as *non-aligned* (Figure 3(a,c)), with three having low values in physical capacity or perception (almost 66% of boys) (Figure 3(d)). Those non-aligned, underestimated their high physical capacity (profiles 2 and 3) and reported higher PA participation than those in profile 4 who overestimated their low physical capacity (Table S.2). In this last profile, the frequency of overweight/obese children was high. For girls, there were more profiles with alignment between actual physical capacity and perception (Figure 4(a,c)). This is positive for the longitudinal development in the association between perceived and actual MC (Stodden et al., 2008) and healthy WS – when both values are high. Similar to boys, three of the five girl profiles had low values in physical capacity or perception (almost 49% of girls). These profiles by sex also support the concern of low levels in actual MC in children (Lima et al., 2017), with boys presenting a higher frequency of overweight/obesity (Gutiérrez et al., 2015). Thus, it seems that sex affects the type and amount of profiles found. According to our results, it is suggested that sex could be considered more in the model of motor development by Stodden et al. (2008). Barnett et al. (2016a) found a diversity of consistent correlates for actual MC such as age (increasing) and sex (male). However, the theoretical model of motor development according to the individuals' age and sex not only in a variable-centred approach but also in a person-centred approach has not been studied yet. Whilst it would have been ideal to consider sex and age in the one modelling approach there was not the statistical power for that – which is a study limitation. Nevertheless this exploratory research can pave the way for larger powered studies.

In terms of other study limitations, PA was assessed via a one on one interview with each child using a questionnaire that was designed to be completed as self-report which might increase the risk of overestimation (De Meester et al., 2016). Furthermore, it remains unclear and underexplored as to how muscular strength relates to actual MC (Tompsett et al., 2017) as only one component of physical fitness (i.e., leg power) was included and physical fitness is composed of different components (e.g., cardiorespiratory fitness or flexibility). Also, recent studies have identified that PA engagement in young children may be associated differently with actual MC depending upon the type of skill (i.e., locomotion or object control) (Barnett et al., 2015), but in the current study FMS as a whole were considered for analyses. It was thought separate locomotor and object control models would have added even more complexity to the already complex profiles.

Conclusion

The study of children's motor development from a person-centred approach provides an insight for understanding how physical capacity and perceived MC affect children's health behaviour and outcomes (e.g., PA participation and WS). This type of analysis shows how to identify the children who need intervention the most. Thus, by assessing physical capacity and perceived MC, researchers can identify children likely to also

present with unhealthy WS. In this line, children who overestimate their relative low levels of physical capacity seem to be less physically active (self-reported) and more children with this profile are also overweight/obese. The SOM obtained in this study could be used as a screening tool in physical education classes. Thus, accordingly with the membership cluster of students, researchers, therapists and/or physical education teachers could provide cluster-individualised interventions to promote PA. For instance, children classified in clusters as *non-aligned* with low values in physical capacity or perception could be oriented to enhance them in order to promote a change towards desirable *aligned-high* profiles.

In addition, factors such as the children's age and sex seem to further describe the profiles found. On the one hand, older children who accurately estimate their high physical capacity reported higher PA than the younger children who overestimate their physical capacity. Conversely, girls present more aligned or accurate profiles than boys. In boys, those who present high physical capacity reported higher PA than those with low physical capacity. Overall, the profiles very clearly demonstrate that high capable children (i.e., high actual MC and physical fitness) with high perception exhibit higher PA participation and greater amount of normal-weight than those with low physical capacity and/or perception.

Disclosure statement

No potential conflict of interest was reported by the authors.

Funding

This work was supported by the Universitat de València [UV-INV-AE16-471273].

ORCID

Isaac Estevan  <http://orcid.org/0000-0003-3748-2288>

Lisa M. Barnett  <http://orcid.org/0000-0002-9731-625X>

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