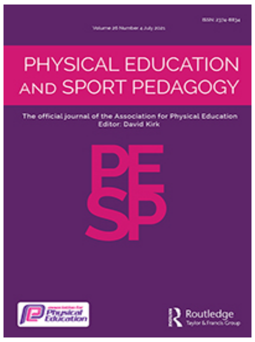

Physical Education and Sport Pedagogy

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/cpes20

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To cite this article: Isaac Estevan, Farid Bardid, Till Utesch, Cristina Menescardi, Lisa M. Barnett & Isabel Castillo (2021) Examining early adolescents' motivation for physical education: associations with actual and perceived motor competence, Physical Education and Sport Pedagogy, 26:4, 359-374, DOI: 10.1080/17408989.2020.1806995

To link to this article: https://doi.org/10.1080/17408989.2020.1806995

PHYSICAL EDUCATION AND SPORT PEDAGOGY
2021, VOL. 26, NO. 4, 359–374
https://doi.org/10.1080/17408989.2020.1806995

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Examining early adolescents' motivation for physical education: associations with actual and perceived motor competence

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ABSTRACT

Background: The dynamic nature of physical education (PE) requires careful consideration of lesson planning and delivery in order to promote health and wellbeing and to achieve various learning goals. One such goal is promoting personal and social development to support students to value and lead a healthy and active lifestyle, especially during transition into adolescence. In order to design learning environments that support students' engagement in PE, it is important to understand how outcomes such as motor competence (MC) influence motivation for PE. There are two approaches to understand MC, actual and perceived MC, and both have implications for healthy lifestyles in childhood and adolescence. Therefore, this study examined associations of actual and perceived MC with young adolescents' motivation for PE.

Method: A sample of 236 students 11–14 years of age ($M = 13.01$, $SD = .72$) participated in the study. Assessments included actual MC (Körperkoordinations test for Kinder; KTK), perceived MC (self-administered form of the pictorial scale of Perceived Movement Skill Competence; PMSC) and motivation for PE (Perceived Locus of Causality Scale; PLOC). Polynomial regression with Response Surface Analyses were conducted to examine the influence of actual and perceived MC on motivation for PE.

Findings: The results showed weak-to-moderate positive associations of actual and perceived MC with students' motivation for PE. Perceived MC explained about 12% of the variance of student's self-determined motivation towards PE. This effect was larger in students with lower levels of perceived MC compared to students with higher levels of perceived MC.

Discussion: Taking into account that both actual and perceived MC are synergistically related but only perceived MC explains self-determined motivation, our results suggest that perceived MC is an important factor to consider when attempting to promote an active and healthy lifestyle. Using the developmental model of motor competence [Stodden et al. 2008. "A Developmental Perspective on the Role of Motor Skill Competence in Physical Activity: An Emergent Relationship." *Quest* 60 (2): 290–306] and self-determination theory [Deci and Ryan 2000. "The "What" and "Why" of Goal Pursuits: Human Needs and the Self-Determination of Behavior." *Psychological Inquiry* 11 (4): 227–268.

ARTICLE HISTORY
Received 17 December 2019
Accepted 23 July 2020

KEYWORDS
Motor development; perception; motivation; physical education; adolescence

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doi:10.1207/S15327965PLI1104_01], we discuss the findings in relation to the importance of considering perceived MC as an explicit outcome in the PE curriculum.
Conclusion: During early adolescence, PE programs should not only focus on teaching movement skills but also fostering perceived MC in order to promote motivation for PE, especially among students with lower levels of self-perception. For this, pedagogical approaches such as need supportive teaching derived from self-determination theory can be used to help students become competent, confident and motivated movers.

Introduction

From a pedagogical and health perspective (e.g. Health-Based Physical Education (PE); Haerens et al. 2011), school PE curricula should not only contribute to individuals' health and wellbeing but also support the development of attributes such as valuing effort and responsibility, understanding and respecting peers, developing self-confidence, and accepting own and others' physical appearance. PE is then seen as a way to promote not only physical but also affective, cognitive, and social development (Usher, Edwards, and de Meyrick 2015). Within the context of PE, in order to value and take responsibility for engagement in lifelong physical activity (PA) (Tyler et al. 2018), particular attention is given to motor competence (MC), which refers to the degree of proficiency in performing a wide range of motor skills (e.g. jumping, catching, balancing) as well as the underlying mechanisms (e.g. control and coordination) required in daily life activities (Robinson et al. 2015; Utesch and Bardid 2019). MC is associated with a range of health outcomes including physical activity (see Barnett, Lai, et al. 2016, for a systematic review). Currently, with many children and adolescents demonstrating low levels of MC (Lopes, Stodden, and Rodrigues 2017; Barnett, Stodden, et al. 2016), motor skill development needs to remain a key component of the PE curriculum (Hardy et al. 2013).

Within and beyond the PE context, MC plays an important role in helping children develop a healthy and active lifestyle (Barnett, Lai, et al. 2016; Robinson et al. 2015). In their model, Stodden et al. (2008) argued that children with higher levels of MC – in combination with higher levels of perceived MC [i.e. a person's perception of his/her actual MC (Estevan and Barnett 2018)] and physical fitness – will be more likely to participate in physical activity and develop a healthy weight. In contrast, children with lower levels of actual MC will be less likely to be physically active (Stodden et al. 2008). Literature shows that exposure to environmental factors, such as education opportunities in PE, is important to develop adequate levels of actual MC (see Tompsett et al. 2017, for a systematic review). As such, teaching motor skills aims to promote MC to maximise students' health and wellbeing through encouraging and facilitating PA across the lifespan (Breslin et al. 2012).

Considering one of the priorities in the curriculum is valuing movement and developing actual MC (Usher, Edwards, and de Meyrick 2015), it is surprising to find in some European countries (e.g. Spain) that perceived MC is not an explicit learning outcome in the PE curricula (Boletín Oficial del Estado 2014a) despite its pedagogical and health-oriented potential (Stodden et al. 2008). While children may first perceive effort as mastery of motor skills, they seem to incorporate a more abstract perspective in their descriptions as they grow older and transition into adolescence (Estevan and Barnett 2018; Wigfield and Karpathian 1991). It is argued that initially children begin with an understanding of the world based on mental action schemes, followed by an understanding based on mental representations, and finally by an understanding based on internalised organised operations (Goswami 2010). As such, perception of MC may be better constructed from early adolescence onwards as an individual's ability to make real judgements about his/her MC (Estevan and Barnett 2018).

Low perception of competence has been highlighted as a psychological limitation contributing to an unhealthy lifestyle (Rubeli et al. 2020). Additionally, individuals with high perceptions of competence exhibit higher self-esteem, exert greater effort and select tasks that challenge their ability (Weiss and Amorose 2005). For instance, an Australian qualitative study identified that adolescents perceived MC influences their motivation towards sport and PA (Barnett et al. 2013). A subsequent meta-analysis reported perceived physical competence, in particular perceived sport competence, is positively associated with PA (Babic et al. 2014). Also, Belgian adolescents with high-perceived sport competence (but low actual MC) were more physically active than adolescents who accurately estimated themselves (but also had low actual MC) (De Meester et al. 2016). Furthermore, a substantial proportion of young people do not undertake sufficient PA (Currie et al. 2012), which is shown to not only be attributed to low perceived MC but also to low MC development (Robinson et al. 2015; Stodden et al. 2008). Recent literature has also highlighted the importance of the association between actual and perceived MC in children and adolescents, as when these are misaligned, there can be associations with unhealthy behaviours and outcomes (Bardid et al. 2016; De Meester et al. 2016; Estevan et al. 2019a). Hence, there is a strong evidence base for the negative effects of low levels of actual and perceived MC on children's and adolescents' health-related behaviours (Hulteen et al. 2018; Robinson et al. 2015; Stodden et al. 2008).

Another key aspect in relation to the association between actual and perceived MC, is its contribution to motivation towards PA, sports and PE (Bardid et al. 2016; De Meester et al. 2016). Adolescents' perceived sport competence, but not actual MC seems to be positively associated with their autonomous motivation (De Meester et al. 2016). In Self-determination theory (SDT; Deci and Ryan 2000), three types of motivation are distinguished: intrinsic, extrinsic and amotivation, which correspond to five types of behavioural regulations situated along a continuum ranging from high to low self-determination. Intrinsic motivation represents the highest degree of self-determined motivation. Four regulation types of extrinsic motivation vary in terms of the degree of self-determination, from higher to lower: integrated, identified, introjected and external motivation. Amotivation refers to the lack of motivation. Intrinsic motivation, integrated and identified regulation have been described as self-determined or autonomous motivation, whereas introjected and external regulation have been described as non-self-determined or controlled motivation (Deci and Ryan 1987). Self-determined motivation (i.e. autonomous motivation) involves the regulation of behaviour with the experiences of volition, psychological freedom, and reflective self-endorsement and is considered the most optimal form of motivation (e.g. students take part in PE because they enjoy doing it, learning new skills). Controlled motivation refers to pressured engagement in an activity. The student performs the activity as a mean to achieve or to avoid something (a reward or punishment) but not because of the sense of the activity (e.g. he/she participates in the class because they want to get a good report in PE). Amotivation also refers to the lack of intentionality or engagement in behaviours for unknown reasons (e.g. students do not see why they should have PE lessons) (Deci and Ryan 2000). The different types of motivation can be combined into one self-determined motivation index (SDI) which reflects the level of self-determined motivation (for more details see Vallerand and Rousseau 2001). A positive score indicates that a person's motivation is self-determined, whereas a negative score reflects non-self-determined motivation (Grouzet et al. 2004; Kalaja et al. 2009).

In this line, school-based PE is seen as a critical pathway for children to adopt a healthy lifestyle by offering positive opportunities to develop their MC (Kalaja et al. 2010). PE should promote a healthy and active lifestyle (Kerner, Haerens, and Kirk 2018) by providing personally relevant, interesting, and enjoyable activities that positively influence students' intrinsic motivation to engage in physical activity within and outside school (Haerens et al. 2011). Harter's (1978) theory of competence motivation states that, if a student has a positive perceived physical competence and believes that he/she has mastered the performance of a goal-directed behaviour, they will be more inclined to be motivated to repeat that behaviour. Moreover, when students find activities inherently interesting, meaningful, and enjoyable, or when activities hold personal relevance, they will be more likely to engage in these activities outside PE (Haerens et al. 2010; Haerens et al. 2011). As such, motivation is an important underlying factor in effective behaviours (e.g. PA participation) that can contribute to a better understanding of actual and perceived MC and their role in PA participation (Bardid et al. 2016).

SDT also purports that there are three basic psychological needs underlying self-determined motivation (Deci and Ryan 2000): perception of competence, autonomy and relatedness. Effective behaviour (e.g. PA participation) and behaviour change not only requires individuals to feel autonomous in doing the behaviour; or to feel connected to and understood by others, they also need to perceive themselves as competent to enact the requisite behaviours in order to yield desired outcomes (Deci and Ryan 2000). In this line, those who feel more competent would also have larger self-determined motivation for sports and vice versa (e.g. Bardid et al. 2016; Castillo, Molina-García, and Álvarez 2010). That is, a positive relationship between perceived sport competence and motivation for sports exists (De Meester et al. 2016). Similar results were found in the PE field supporting that perceived competence is positively associated with PA and sport behaviour (Halvari et al. 2009). So, perceived MC might also influence motivation to participate in PE settings (Robinson 2011). Those students who feel more autonomously motivated also present more interest, effort, satisfaction and commitment to PE contents (Vallerand 2007). According to Kalaja et al. (2009) self-determined motivation promotes adaptive cognitive, affective and behavioural functioning by facilitating enhanced learning, improved performance, higher interest and greater effort. Furthermore, students with low levels of both actual MC and perceived sport competence show lower levels of self-determined motivation for PE than those with higher levels of actual and perceived MC (De Meester et al. 2016).

Accordingly, it would be expected that students' actual and perceived MC are positively associated with self-determined motivation. However, due to the dynamic and synergistic nature of actual and perceived MC as a result of different personal trajectories in motor and cognitive development (Estevan and Barnett 2018), the influence of each factor to an individual's motivation may differ (Hastie et al. 2011). Thus, by studying linear and curvilinear associations the purpose of the current study was to examine the influence of actual and perceived MC on motivation for PE in early adolescence. Based on previous studies (Bardid et al. 2016; De Meester et al. 2016), we hypothesised that actual and perceived MC will account for early adolescents' motivation for PE with perceived MC being the main influencing factor.

Materials and methods

Participants

Eight schools (one primary and seven high-schools) in the Valencian Community (Spain) were recruited using convenience sampling. A total of 236 students (45.8% girls), 11–14 years of age (M = 13.01, SD = .72) participated in the study. All the school principals contacted agreed to participate in the study and the parents or guardian provided written informed consent (84.5% consent rate). Students were included in data analyses if they: (1) were between 11 and 14 years old; (2) were in full-time enrolment in the last year of primary school or first and second year of high-school; (3) had Spanish as their main language at school; (4) provided verbal assent to be involved.

Procedure

Data collection was conducted by trained research assistants (all specialists in teaching PE in primary and/or secondary school) in the respective schools between February and May 2018 during school hours. Approval was obtained from the Institutional Review Board of the University of the first author (H1446557620395).

Prior to actual MC assessments, each student completed an inventory composed of the second version of the pictorial scale of Perceived Movement Skill Competence (PMSC) adapted to be self-reported (Estevan et al. 2018), and the Perceived Locus of Causality Scale (PLOC; Moreno-Murcia, Coll, and Garzón 2009). The administration of these two questionnaires was verbally guided by one research assistant to guarantee that participants understood each item. For the actual MC assessment, the Körperkoordinations test for Kinder (KTK; Kiphard and Schilling 2007) was used. Students attended in groups of 16 in a sports hall and rotated around four stations, each of which were manned by a research assistant. The time required for assessing participants' actual and perceived MC and motivation for PE was approximately 20–25 min per student.

Instruments

Actual motor competence. Early adolescents' actual MC was assessed using the KTK (Kiphard and Schilling 2007; Torralba et al. 2016), a product-oriented based assessment valid for individuals aged 5–14 years. It consists of four non-sport-specific tasks that measure gross motor coordination: (1) walking backwards along balance beams of decreasing width (6.0, 4.5, 3.0 cm), (2) moving sideways on wooden boards during 20 s, (3) jumping sideways over a slat for 15 s, and (4) hopping over foam obstacles with increasing height in consecutive steps of 5 cm. All the tasks were video recorded for subsequent coding. The raw performance score on each task was converted into a standardised motor quotient adjusted for age (all four tasks) and sex (the third and fourth tasks) (Kiphard and Schilling 2007). The range for each task can be seen in Table 1. The sum of the four standardised scores was used in the analyses as a total motor quotient (MQ). The total MQ can be used to classify individual performance into five categories (see Kiphard and Schilling 2007): 'impaired' (MQ ≤ 70), 'poor' (70 < MQ ≤ 85), 'normal' (85 < MQ ≤ 115), 'good' (115 < MQ ≤ 130), and 'high' (130 < MQ ≤ 145). In the current study, the reliability (assessed by the Cronbach's alpha) of the KTK was .66 (95% CI, .59 – .73).

Perceived motor competence. Perceived MC was assessed by using the PMSC (Barnett et al. 2015) validated for use in this country (Estevan et al. 2019b) and in adolescents (Rogers, Barnett, and Lander 2018). This version consists of 13 items representing locomotor skills (6 items: run, gallop, hop, slide, jump and skipping) and object control skills (7 items: overarm throw, underarm throw, bounce, catch, kick, hit a ball with one or two hands) (Estevan et al. 2019b). Each item was accompanied by two pictures, one depicting the task performed appropriately (at the side of the highest value) and the other not (at the side of the lowest value). Each item was rated on a 4-point Likert-type rating scale being four as 'really good', three as 'pretty good', two as 'sort of good' and one as 'not so good'. Accordingly, the score range for the PMSC total scale was 13–52, with six locomotion skills, and seven object control skills. Confirmatory factor analysis by using EQS software and robust method used for the current sample informed of a one factor model χ^2 (65) = 158.45; $p < .001$; CFI = .902; SRMR = .066; RMSEA = .076 (90% CI = .063-.093). In this line, Carmines and McIver (1981) suggested that values of χ^2/df lower than 3 inform as to a good fit model. Moreover, according to Hu and Bentler (1999), values of CFI equal or higher than .90 can

Table 1. Descriptive statistics of the variables of study.

	M	*SD*	Range
Actual Motor Competence	86.11	16.18	41–126
Walking balance	86.76	17.87	49–122
Jumping sideways	94.17	15.61	48–112
Moving sideways	102.10	19.27	50–144
Hopping for height	74.41	18.18	36–132
Perceived Motor Competence	34.45	7.71	19–52
Locomotor skills	15.34	3.61	8–24
Object control skills	19.11	4.71	9–28
Self-determined Motivation	19.63	13.44	−23.5–46.0
Intrinsic Motivation	15.54	3.31	4–20
Identified Regulation	15.60	3.55	4–20
Introjected Regulation	12.03	3.69	4–20
External Regulation	11.16	3.80	4–20
Amotivation	7.73	3.31	4–20

be interpreted as acceptable fit. Values of RMSEA between .05 and .10 can be interpreted as acceptable (Hu and Bentler 1999). Two sex-specific versions of the PMSC were used: one for boys and one for girls. The internal consistency for the PMSC total scale, assessed by computing Cronbach's alpha, was .88 (95% CI, .86 – .91). Test-retest reliability reassessed in a random subsample from the current study ($n = 53$) 15 days apart showed an Intraclass Correlation Coefficient equal to .85 (CI 95%, .73 – .92).

PE self-determined motivation. To assess students' contextual motivation towards PE classes, the Spanish version of the PLOC scale was used (Goudas, Biddle, and Fox 1994; Moreno-Murcia, Coll, and Garzón 2009). It consists of 20 items, headed by the phrase 'I participate in physical education class because … ', to measure five dimensions (4 items for each one): intrinsic motivation (e.g. I enjoy learning new things), identified regulation (e.g. it is important to do well in PE), introjected regulation (e.g. I would feel bad if I did not do it), external regulation (e.g. it is what I am supposed to do), and amotivation (e.g. I do not understand why we have to study PE). Each item was headed with the stem 'I participate in Physical Education classes because … ', and was rated on a 5-point Likert scale, ranging from 1 (totally disagree) to 5 (totally agree). The SDI was calculated from the scores obtained in each of the PLOC subscales, as follows: (2 × intrinsic motivation + identified regulation) – ((introjected regulation + external regulation)/2 + 2 × amotivation). In the current study, the internal consistency (Cronbach's alpha) for the PLOC five dimensions ranged from .65 to .83 which is considered acceptable in scales comprised of a low number of items (Hair et al. 2006; van Griethuijsen et al. 2015) (further results of reliability and inter-dimension correlation is shown in Table 2).

Statistical analysis

First, the correlations between types of regulation, SDI, actual and perceived MC are presented using bivariate Pearson correlation coefficients.

Second, multiple linear regressions and second degree polynomial regressions with Response Surface Analysis (RSA) (Schönbrodt 2017) were conducted in order to examine both linear and curvilinear effects of actual and perceived MC on students self-determined motivation towards PE (using the SDI). Whilst the RSA is considered a superior analysis for our purpose, the multiple linear regression is also conducted in order to compare results and because readers will be more familiar with this approach. The RSA is used, because it provides numerous advantages in comparison to an ordinary least square multiple regression. In general, ordinal least square models calculate associations for each variable in so-called 'full models' while the RSA accounts for the statistical principal of parsimony, which means that statistical modeling should always aim to find the best fitting and, at the same time, the most parsimonious model, instead of the best fitting and most complex model. This approach ensures that over- and under-fitting is avoided in the statistical modeling process by applying a maximum likelihood estimator that helps to examine the effects of diverse fit patterns

Table 2. Cronbach's alpha and Pearson correlation of the variables of study and the dimensions of the perceived locus of causality scale.

	SDI	1	2	3	4	5
1. Intrinsic motivation	.80**					
2. Identified regulation	.67**	.77**				
3. Introjected regulation	.02	.36**	.46**			
4. External regulation	−.34**	.04	.12	.46**		
5. Amotivation	−.78**	−.32**	−.21**	.15**	.39**	
Actual motor competence	.15*	.09	.15*	.12	−.04	−.15*
Perceived motor competence	.29**	.35**	.36**	.28**	−.01	−.11
Cronbach's alpha		.78	.83	.67	.65	.66

Note: SDI: Self-determined motivation. *$p < .05$; **$p < .001$.

of two predictor variables and one outcome variable using a path modeling approach. The RSA computes several models with a priori specified variable patterns between the different regression coefficients estimated and compared to each other. These models are for example: the null model, one model with only the linear main effect of the first predictor variable (*only-x*), another model with only the linear main effect of the second predictor variable (*only-y*), another model with both linear effects (*additive*). More models can be estimated that add different patterns, including the curvilinear effects and the interaction effects (for detailed information see Schönbrodt 2017). In order to find the best fitting but also most parsimonious model, Akaike's Information Criteria (Bozdogan 1987) shows the relative best model fit considering all models. Model fit of the best fitting models will be reported using the following criteria: an information criterion (AIC), an incremental measure (i.e. comparative fit indices (CFI)), absolute significance of the model (p) and explained variance (adjusted R^2). Two or more models are considered to equally fit the data when ΔAIC is smaller than 2 and the CFI is equal to or above .95 for all models (Schönbrodt 2017). The multiple linear regression is computed using Equation (1) while the polynomial regression of the second degree is defined by Equation (2).

$$\begin{aligned}\text{self-determination index} \sim b_0 + b_1{*}\text{actual MC} + b_2{*}\text{perceived MC} \\ + b_4{*}\text{actual MC}{*}\text{perceived MC}\end{aligned} \tag{1}$$

$$\begin{aligned}\text{self-determination index} \sim b_0 + b_1{*}\text{actual MC} + b_2{*}\text{perceived MC} + b_3{*}\text{actual MC}^2 \\ + b_4{*}\text{actual MC}{*}\text{perceived MC} + b_5{*}\text{perceived MC}^2\end{aligned} \tag{2}$$

The intercept is b_0. Regression coefficients in the RSA are b_1 to b_5 that will be shown in their original scale and as standardised β weights. The linear main effects are b_1 (actual MC) and b_2 (perceived MC). The curvilinear main effects are b_3 (actual MC) and b_5 (perceived MC), but these two are not necessarily part of the most parsimonious model. The interaction effect is b_4 (actual MC * perceived MC). Both predictors (i.e. perceived MC, actual MC) are z-transformed by sex in order to control for gender effects. In the RSA, values are estimated using the maximum likelihood estimator and robust standard errors, which are robust against violations of the assumption of normality.

Statistical analyses were executed using *R* (R Core Team 2013) and primarily the *RSA* package (Schönbrodt 2017). Open code and data are provided in this study (https://osf.io/e4v6w/).

Results

Descriptive results of actual MC, perceived MC and self-determined motivation for PE are shown in Table 1. With regard to actual MC, students had a mean MQ of 86.11 (16.18), which is below the average MQ of 100 in the normal category between 85 and 115. Forty-seven percent of the students scored in the 'normal' range of motor competence. Proportions scoring below average are 16.1% (i.e. 'impaired') and 33.5% (i.e. 'poor'). In contrast, only 3.4% of the students scored above average (i.e. 'good') with none scoring 'high'. Students reported relatively high scores on perceived MC of 34.45 (7.71). They also scored relatively high on self-determined motivation for PE of 19.63 (13.44). Actual and perceived MC were weakly and moderately positively associated with student's self-determined motivation towards PE, respectively (see Table 2). The relationship between actual and perceived MC was moderate ($r = .37$; $p < .001$).

Secondly, the ordinary linear regression was calculated. The results show no significant effect for actual MC, nor for the interaction effect (Table 3). Perceived MC shows a medium sized effect ($\beta = 0.309$, $p < .01$) to predict students' PE self-determined motivation. So, multiple linear regressions show that perceived MC but not actual MC explains students' self-determined motivation towards PE.

Table 3. Linear regression models for explaining Self-determined motivation for physical education.

Predictors	Est	SE	β	CI	p
(Intercept)	19.780	0.868			<.001
Actual motor competence	1.255	0.890	0.092	−0.036 – 0.221	.160
Perceived motor competence	4.206	0.895	0.309	0.180 – 0.438	<.001
Interaction	−0.341	0.841	−0.026	−0.150 – 0.099	.685
Observations	235				
R^2 / adjusted R^2	0.119/0.107				

Note: Est. is the non-standardised regression estimate. β is the standardised regression estimate.

Table 4. Model comparison for the response surface analysis ordered by ΔAIC.

Model names	k	AICc	ΔAIC	CFI	adj. R^2	χ^2	p^2_χ
Only-y	3	1865.79	0	0.95	0.11	–	<.001
Additive	4	1865.91	0.12	0.98	0.12	1.06	<.001
Only-y^2	4	1866.09	0.30	0.98	0.11	1.16	<.001
Interaction Effect	5	1867.80	2.01	0.95	0.11	2.73	<.001
SRRR	6	1867.82	2.02	0.99	0.11	2.75	<.001

Note: Only best five models are shown in this Table. *k*: number of parameters; AICc: corrected Akaike Information Criterion; CFI: Comparative fit index; adj. R^2: adjusted variance explained by the model; χ^2: model test of the only-y vs. model; p^2_χ: *p* value of SRRR vs. model. SRRR: Shifted and rotated rising ridge model.

Thirdly, regarding the RSA, the only-y model (the main effect of perceived MC), the additive (the main effects of actual and perceived MC) as well as the only-y^2 (the curvilinear effect of perceived MC) show a similar model fit. This is because ΔAIC is smaller than 2 and the CFI is equal to or above .95 for all models (Table 4; Schönbrodt 2017). Therefore, the interaction model and the shifted and rotated rising ridge model are not considered.

The RSA show that, across all three equally likely models, perceived MC significantly predicts student's self-determined motivation towards PE. The only-y^2 model provides information about the curvilinear effect. It indicates that the effect of perceived MC is not the same for every individual. The effect on self-determined motivation is small for students with high levels of perceived MC while the effect is larger for students with low levels of perceived CM (see Figure 1). This means that the difference in motivation is larger between children with very low and low self-perception compared to children with high or very high self-perception. However, actual MC is only part of one out of three equally probable models, i.e. the additive model, which does not show a significant effect ($p = 0.173$) (Table 5). Mainly perceived MC explains about 12% of the variance of student's self-determined motivation towards PE.

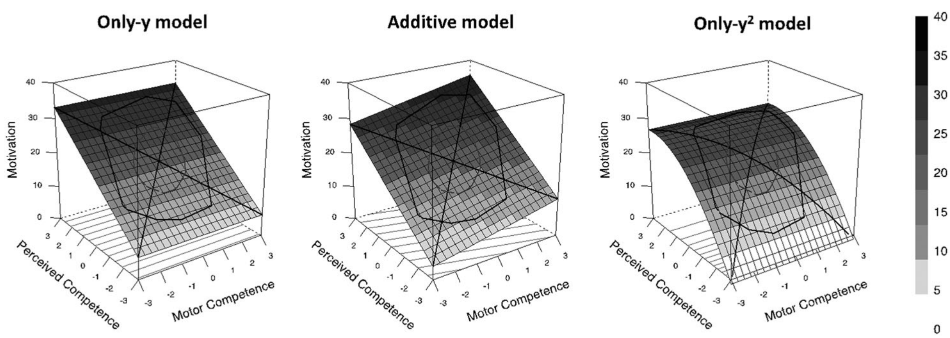

Figure 1. Response surface analysis illustrating the effects of perceived and actual motor competence on student's self-determined motivation towards physical education. Note: Motor competence refers to actual motor competence. Perceived competence refers to perceived motor competence. Motivation refers to self-determined motivation.

Table 5. Results of the response surface analysis examining self-determined motivation for physical education.

	Est.	Robust *SE*	95 % CI (lower)	95 % CI (upper)	β	*p*	adj. R^2
Only-y							.111
Intercept	19.677	0.826	18.059	21.295	*1.466*	<.001	
AMC	–	–	–	–	–	–	
PMC	4.481	0.868	2.780	6.181	0.333	<.001	
Additive							.118
Intercept	19.677	0.822	18.065	21.288	*1.466*	<.001	
AMC	1.201	0.882	−0.527	2.930	.089	.173	
PMC	4.106	0.957	2.229	5.982	.305	*.001*	
Only-y^2							.117
Intercept	20.535	1.014	18.547	22.523	*1.530*	<.001	
AMC	–	–	–	–	–	–	
PMC	4.670	0.871	2.963	6.378	0.347	<.001	
PMC^2	−0.862	0.671	−2.177	0.453	−0.082	*.199*	

Note: Est. is the non-standardised regression estimate. β is the standardised regression estimate. AMC: actual motor competence; PMC: perceived motor competence.

Discussion

The dynamic nature of PE requires careful consideration of lesson planning and delivery in order to promote health and wellbeing and to achieve proposed learning outcomes. Developing MC and enhancing personal and social development, amongst others, not only support students to be physically active, but are considered important for promoting engagement in lifelong PA (Bailey et al. 2009). To this end, school-based PA interventions have been shown to enhance actual MC in both children and adolescents (see Lai et al. 2014, for a systematic review). It is noteworthy that most health-related MC interventions in PE are mainly focused on implementing strategies and activities that enhance actual MC (e.g. Lander et al. 2017). However, perceived sport competence is also important for engagement and participation in youth PA and sport (De Meester et al. 2016). Moreover, few studies have investigated to what extent both actual and perceived MC are associated with motivation for PE. Thus, the purpose of the current study was to examine the influence of actual and perceived MC on early adolescents' motivation for PE.

Results from the current study showed actual and perceived MC were positively related. In this line, as students' age, the association between actual and perceived MC seems to be stronger (Estevan and Barnett 2018; Stodden et al. 2008). That is, during childhood, research addressing this association showed some uncertain results (Lubans et al. 2010) with studies presenting weak or no relationship (Spessato et al. 2013) and others showing moderate associations (Barnett, Ridgers, and Salmon 2015). In our study, a moderate association between actual and perceived MC was found. Being on a positive trajectory in terms of actual and perceived MC association means a youngster will be more likely to engage in physical activities throughout adolescence and into adulthood (Kavanagh, Issartel, and Moran 2019). However, the extent to which both actual and perceived MC are associated with motivation for PE has been understudied.

According to SDT, there are several postulates to be considered in the interpretation of the different types of behavioural regulation. Dimensions defining the structure of the motivation should match the strength of correlation, i.e. the nearer on the self-determination continuum, the higher the correlation (Goudas, Biddle, and Fox 1994; Moreno-Murcia, Coll, and Garzón 2009). That is, the strength of correlation should gradually decrease as the dimensions grow further apart on the continuum (Kalaja et al. 2009). It is also expected that the extremes of the continuum show a negative correlation. The aforementioned assumptions derived from the SDT are matched in the current study. Furthermore, self-determined motivation also correlates gradually in a 'V' path throughout the continuum changing from positive to negative, and SDI has been previously used for studying the association with MC (Kalaja et al. 2009). So, using SDI can be seen as a non-complex and practical manner for PE teachers and practitioners to assess the relative autonomy of motivation towards PE and evaluate its relationship with actual and perceived MC.

Horn (2018) stated that actual and perceived MC could predict children's and adolescents' motivation and wellbeing. Interestingly, in the current study, perceived MC seems to be more relevant than actual MC in influencing motivation for PE in early adolescence. That is, perceived MC (not actual MC) explained around 12% of the samples' self-determined motivation in PE (see Table 5). It should be noted that around half of the participants in the current study showed normal or good levels of actual MC (i.e. 47.04% normal, 3.40% good) with no one showing a high level. Our study supports previous findings of children in primary school (Duncan et al. 2020) and early adolescents in secondary school (O'Brien, Belton, and Issartel 2016) where only a low proportion showed mastery in actual MC. It could be argued that primary school PE provides the ideal environment to promote and enhance students' MC (Lopes, Stodden, and Rodrigues 2017; Martin, Rudisill, and Hastie 2009). Even though promoting MC is a main goal in primary and secondary school curriculum (Boletín Oficial del Estado 2014a, 2014b, respectively); almost half of the sample under study showed below average levels of actual MC (with 33.5% and 16.1% categorised as 'poor' and 'impaired', respectively). Individuals are expected to build a strong foundation of motor skills in early and middle childhood in order to participate successfully in different context-specific physical activities (Bolger et al. 2018). However, similar to O'Brien, Belton, and Issartel (2016), present findings suggest that early adolescents might struggle to engage in physical activities requiring more complex or sport-specific skills. As such, future research is needed to explore pedagogical aspects such as level of instruction, type of feedback and practice time in order to support MC development. This is important as actual MC is associated with many health outcomes including perceived MC (Robinson et al. 2015). This is in line with Harter's competence motivation theory (1987) in that successful mastery of motor skill tasks promotes positive perceptions of MC, which in turn motivates children and adolescents to further engage in such activities. In this view, perceived MC plays a key role in engaging young people in PA, active games and/or sports (Jekauc et al. 2017).

Our results suggest that perceived MC is indeed an important factor to address when attempting to promote an active and healthy lifestyle (Morrison et al. 2018). The curvilinear association suggests there is a steep curve for children with low perceived MC levels, which means there is a large effect of perceived MC on self-determined motivation for those children (see Figure 1(C)). Therefore, taking into account the results of the current study in terms of low levels of actual MC and the importance of perceived MC in motivation for PE, PE programs should not only focus on fostering actual MC but also students' MC perception. Fostering perceived MC would help increase motivation for PE, which would encourage students to engage and persist in motor skill challenges (Kalaja et al. 2009). To this end, a holistic approach to PE, such as models-based practice, is suggested. In this approach, different pedagogical aspects are considered and aligned including learning outcomes, programme and lesson content, teaching styles and strategies, and assessment (Cairney et al. 2019; Kirk 2013).

With regards to the perceived MC measurement, the adapted version of the PMSC to be self-reported showed acceptable fit indexes and good evidence of reliability (i.e. internal consistency and test-retest reliability). As a result, in line with Rogers, Barnett, and Lander (2018), the PMSC for youth can be a valid and reliable instrument to be used in the assessment of early adolescents' (i.e. 11–14 years-old) perceived MC.

In the case of the assessment of motivation, we used the self-determination index following the scoring protocol as suggested by Vallerand and Rousseau (2001), which is slightly different to other indexes (e.g. based on using scores from all five PLOC subscales) such as the one suggested by Wilson et al. (2012). Nonetheless, this index has been critiqued as it represents a composite score to reflect motivation along a continuum but it does not consider a person's different types of regulation located on different places of that continuum (Ünlü 2016). As a result, future studies analysing the association of actual and perceived MC with motivation for PE should consider using different algorithms to calculate self-determined motivation and explore different types of motivation. In addition, because the theoretical assumptions and the complex statistical approach using RSA does not allow moderating variables, the analyses were conducted by controlling for sex but the potential moderating role of sex was not examined, so it is recommended that future studies analyse the potential moderating role of sex in the association among actual MC, perceived MC and motivation for PE, and its influence in students' PA participation within and outside school environment.

Practical implications

Games and sports are the most frequent content taught in PE (Kerner, Haerens, and Kirk 2018), with perceived-related content (e.g. perceived MC) not being an explicit specific learning outcome of PE curricula. This could be based on a couple of reasons (Jewett 1989): (a) teaching actual MC is supported by thorough evidence confirming its role of physical activity participation, and (b) the limited knowledge of PE teachers on the affective domain of health. So, despite its indirect suggestion as a content in the Spanish PE curricula (Boletín Oficial del Estado 2014a), perceived MC could be considered by teachers as complex and/or not necessary for inclusion in the curriculum and consequently in PE lessons. When it has been an explicit learning outcome, literature showed contrasting findings. One study found no change in physical self-perception after a 12-week PE programme (Invernizzi et al. 2019) and another study improved adolescents' perceived MC and broader physical self-perceptions (Lander et al. 2019). From an applied perspective, PE teachers should provide an environment in which all early adolescents can experience success, irrespective of their level of actual MC, as this will help to foster positive perceptions of competence (Lander et al. 2019). Systematic review evidence showed mastery oriented motivational climate for learning actual MC is an effective pedagogical approach to promote development of MC (Bandeira et al. 2017). Similarly, teaching PE teachers to use the SAAFE (Supportive, Active, Autonomous, Fair and Enjoyable) principles in PE (as developed by Lubans et al. 2017) has been effective in promoting students' perceived MC (Lander et al. 2019) and also enhancing students' autonomous motivation.

PE should be oriented towards fostering mutual help and tolerance, commitment, interest and self-perception (Eggleston et al. 2012). Due to the influence of perceived MC on motivation in PE, in line with Rubeli et al. (2020) who claimed PE teachers should maintain a reflexive and individualised frame or reference teaching style, we recommend that PE teachers consider adopting a teaching approach that fosters perceived MC, especially before and after the transition of primary to secondary school by emphasising effort, trying hard, and promoting learning and progress because it contributes towards students' behavioural practices to be self-determined in PE (Kalaja et al. 2009). Additionally, it is recommended that PE teachers conduct diagnostic evaluation early on so that they can recognise students with low levels of perceived MC and conduct appropriate intervention that would foster perceived MC. This will also indirectly influence students' self-determined motivation towards PE and promote participation (Davison, Downs, and Birch 2006). Based on SDT, need-supportive teaching is considered to be an appropriate pedagogical approach to support perceived competence and motivation for PE (Van den Berghe et al. 2014). During the lessons, strategies that provide structure before and after the activities such as clear instructions, role models and positive feedback can help support early adolescents' perceived MC and engagement in PE (Haerens et al. 2013; Ryan and Deci 2017).

Conclusions

The present study shows that perceived MC rather than actual MC plays a relevant role in early adolescents' motivation for PE. Moreover, the results show a curvilinear effect of perceived MC on motivation for PE that is not similar for all students, but larger in students with lower levels of perceived MC. This means, students who perceive themselves as low skilled show a relatively large difference in motivation for PE compared to students who perceive themselves as better skilled, while there is almost no difference in students who perceive themselves as highly or very highly skilled. As such, PE programs should not only focus on teaching motor skills but also target students' self-perception of those skills and their motivation for PE, especially for students with low perceived

MC, during the transition from primary to secondary school. For this, pedagogical approaches such as need supportive teaching can be used to help students become more competent, confident and motivated movers.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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