Psychology of Sport & Exercise 45 (2019) 101568

Contents lists available at ScienceDirect

Psychology of Sport & Exercise

journal homepage: www.elsevier.com/locate/psychsport

Reciprocal effects model of Children's physical activity, physical self-concept, and enjoyment

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ARTICLE INFO

Keywords:
Physical activity
Enjoyment
Physical self-concept
Reciprocal effects model

ABSTRACT

Objectives: Physical self-concept and physical activity enjoyment represent important determinants for promoting physical activity (PA), especially in children. Promoting PA in children can help develop lifelong healthy behaviors. Therefore, this study investigated Marsh's reciprocal effects model of physical self-concept.
Design: This study used a half-longitudinal design with two groups (boys and girls).
Method: Children in grade 5 ($N = 628$) from six elementary schools in the Midwestern United States completed surveys on physical self-concept, PA enjoyment, and self-reported PA at the beginning and end of one school year (i.e., 8-month interval). Data were analyzed using multi-group structural equation modeling with the CLUSTER option to account for the natural nesting of students within classrooms.
Results: Findings did not support the reciprocal effects model of physical self-concept and PA enjoyment as hypothesized. Rather findings revealed a less defined pattern of self-enhancing and skill-developing relationships. The only skill development relation occurred between PA and future physical self-concept while the only self-enhancement relation occurred between sport self-concept and future PA. PA enjoyment predicted future sport self-concept and coordination self-concept predicted future PA enjoyment.
Conclusions: The temporal interplay between children's physical self-concept and its facets, PA enjoyment, and PA may be more complex than hypothesized in reciprocal effects models. Based on our findings, it appears that sport self-concept may be especially important for children's PA enjoyment and PA. Finally, more precise measurement of PA including its type (e.g., stretching) in future research may produce stronger links with aligning physical self-concept facets (e.g., flexibility).

1. Introduction

According to the United States Report Card on Physical Activity for Children and Youth (National Physical Activity Plan Alliance, 2016), a majority of children do not accumulate 60 min of moderate-to-vigorous physical activity per day. Increasing children's levels of physical activity (PA) is a primary objective of United States Healthy People 2020 because of the comprehensive health benefits and reduction in health risks that are associated with chronic PA participation (Boddy et al., 2014). Investigating determinants that promote youth PA behavior can help address the mission of public health policies such as National PA Plan and Healthy People 2020. In both policies, schools represent an important context for promoting children's PA behaviors because of their reach. However, schools typically create sedentary environments; systematic reviews of school-based PA interventions reveal limited success at changing youths' PA behavior (Rafferty, Breslin, Brennan, & Hassan, 2016; Russ, Webster, Beets, & Phillips, 2015) with successful interventions producing small effects (Brusseau, Hannon, & Burns, 2016).

Self-concepts and positive emotions in diverse domains are critical components of psychological health across the lifespan, especially in school-aged children (Craven & Marsh, 2008; Goetz, Frenzel, Hall, & Pekrun, 2008). Physical self-concept is one's self-beliefs about personal appearance and physical abilities (Marsh, 1996; Marsh, Martin, &

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https://doi.org/10.1016/j.psychsport.2019.101568
Received 27 December 2018; Received in revised form 23 July 2019; Accepted 25 July 2019
Available online 27 July 2019
1469-0292/

Jackson, 2010). Enjoyment is a positive, activating emotion that leads to approach-oriented thoughts and behaviors (Fredrickson, 2001; Goetz et al., 2008). Evidence suggests that physical self-concept (Garn et al., 2016; Lindwall, Asci, & Crocker, 2014; Marsh, Papaioannou, & Theodorakis, 2006) and enjoyment (Barr-Anderson et al., 2008; Dishman et al., 2005) are key psychological determinants of youth PA behaviors. Furthermore, there are close links between positive self-beliefs and positive emotions (Goetz et al., 2008; Pekrun, 2006).

In this study, we investigate longitudinal relationships between physical self-concept and its facets, PA enjoyment, and PA across one school year in grade 5 students. Of most interest are the cross-lagged relationships between constructs after controlling for autoregressive associations. Stated differently, we examine reciprocal relationships among children's PA, physical self-concept, and PA enjoyment at the beginning of the school year (T1) on their levels of PA, physical self-concept, and PA enjoyment at the end of the school year (T2), paying close attention to skill development and self-enhancing effects. Skill development effects represent T1 PA as a predictor of T2 physical self-concepts and PA enjoyment after accounting for their T1 levels. Self-enhancement effects focus on T1 physical self-concepts and PA enjoyment as predictors of T2 PA after accounting T1 PA levels. In the following paragraphs, we outline the theoretical justification for this study including a general description of self-concept theory and research on its reciprocal effects model.

1.1. Physical self-concept

For more than a century, evidence has supported the consistent impact of self-belief constructs such as self-esteem, self-efficacy, and self-concept on health outcomes and quality of life (Bandura, 1986; James, 1890; Harter, 2012). Current models of physical self-concept propose a hierarchical and multidimensional structure (Fox & Wilson, 2008; Marsh et al., 2010; Shavelson, Hubner, & Stanton, 1976). Self-esteem resides at the top of the self-concept model, acting as a global trait-like construct. Multidimensional domains of self-concept such as academic self-concept, physical self-concept, and social self-concept are below self-esteem. Facets for each domain such as appearance self-concept, endurance self-concept, and strength self-concept represent the bottom level of the self-concept model, linking to specific abilities or personal attributes within a domain such as physical self-concept (Marsh et al., 2010). In this study, we focus on physical self-concept and its facets including coordination self-concept, endurance self-concept, flexibility self-concept, health self-concept, strength self-concept, and sport self-concept.[1] We include these facets because of their close proximity to PA behavior[2]. Similarly, some researchers suggest that facets of physical self-concept are advantageous for informing PA interventions because they are assumed to be malleable to relevant contextual demands (Lindwall et al., 2014; Schmidt, Valkanover, Roebers, & Conzelmann, 2013). For example, children participating in a distance-running program are likely to see changes in their endurance self-concept because of the connection between running and endurance.

Developmental researchers suggest that children are generally more optimistic in their self-beliefs including self-concepts compared to older segments of the population (Harter, 2012; Marsh, Craven, & Debus, 1998). However, with the increasing trends of sedentary behavior and exposure to screen time in younger populations (Potter, Spence, Boule, Stearns, & Carson, 2018), there is a pressing need for further investigation into children's physical self-concept and its correlates. Research on the structure and relations of self-concept constructs is termed within-network research, while investigations on relations between self-concept constructs and constructs outside the self-concept framework, such as PA and PA enjoyment, represents between-network research (Byrne, 1984). In this study, we take a between-network focus using the reciprocal effects model of self-concept (Marsh et al., 2006).

1.2. Reciprocal effects model of self-concept

The reciprocal effects model of self-concept focuses on self-enhancement and skill-development hypotheses (Calysn & Kenny, 1977; Sonstroem & Morgan, 1989). The self-enhancement hypothesis suggests that a positive self-concept energizes a person's thoughts and behaviors (Sonstroem, Harlow, & Josephs, 1994). Thus, a positive evaluation of one's self-concept leads to behavioral engagement, situating self-concept as a determinant of behavior. On the other hand, the skill-development hypothesis suggests that actions and behaviors drive one's self-concept development. Behavior is the determinant of self-concept in the skill-development hypothesis (Sonstroem & Morgan, 1989). In a meta-analysis study by Babic et al. (2014) on the association between PA and physical self-concept and its facets, small-to-moderate positive associations were revealed across 64 studies. Yet, Babic et al. (2014) note there is still conflicting evidence on whether physical self-concept and its facets are antecedents or outcomes of PA, or if there are reciprocal effects.

Marsh et al. (2006) (see also Lindwall et al., 2014) outlined a **reciprocal effects model** of physical self-concept and self-reported PA, demonstrating that self-enhancement and skill-development hypotheses are both supported over time. Trautwein, Gerlach, and Ludtke (2008) examined reciprocal effects model of physical self-concept and self-reported PA in a large sample of German children using a 15-month interval between two waves of data. Results supported reciprocal effects between PA and physical self-concept, but effects were small. Facets of physical self-concept were not tested. Trautwein and colleagues postulated that the reciprocal effects model may be less pronounced in children compared to adolescents.

However, not all research supports the reciprocal effects model of physical self-concept and self-reported PA. For example, findings from Lemoyne, Valois, and Guay (2015) supported self-enhancing effects of physical self-concept facets on future PA, but not skill development effects. It should be noted, however, the sample consisted of university students using a three-month interval between two waves of data. Furthermore, in an PA intervention study with university female students, Asci (2003) found support for skill development effects for participants completing the ten-week PA treatment (3 days per week, 50 min per session, aerobic activity) on coordination self-concept compared to participants in the control group. However, the group by time effect was not present for physical self-concept and many other facets such as endurance self-concept, strength self-concept, endurance self-concept, and health self-concept. Thus, many unanswered questions remain about the nature of reciprocal effects model of physical self-concept including its facets and PA, especially for children and young adults.

1.3. Physical activity enjoyment

Despite close conceptual links between motivation, emotion, and behavior (Reeve, 2016) few self-concept researchers have investigated emotions within the reciprocal effects model. Motivation and emotion are key regulators of behavior (Fredrickson, 2001; Pekrun, 2006; Weiner, 1985). Achievement motivation researchers often single out enjoyment specifically because of its energizing capabilities. For example, Eccles and Wigfield (1995) define intrinsic value, a major construct in expectancy-value theory of achievement choice, as the enjoyment one attaches to a specific task or domain. Similarly, Pekrun (2006) posits emotions like enjoyment to be powerful predictors of

[1] We did not include the body fat or appearance subscales of the PSDQ-S because multiple school administrators objected to the content of these items suggesting they were inappropriate for their students. Furthermore, we did not include the activity self-concept subscale (e.g., "I do physically active things e.g. jog, dance, bicycle, aerobics, gym, swim at least three times a week) because of its similarity to self-report PA measures.

behavior in control value theory of achievement emotions. In both of these theories, feelings of competence are commonly defined by domain self-concepts (Arens, Schmidt, & Preckel, 2018; Putwain et al., 2018). Research in expectancy value theory clearly demonstrates that feelings of competence relates to changes in intrinsic value over time (Arens et al., 2018; Jacobs, Lanza, Osgood, Eccles, & Wigfield, 2002). Similarly, Goetz et al. (2008) report "… it is assumed that self-appraisals of competence [self-concept] make it possible to enjoy achievement-related activities in a given domain" (p. 15).

The directional relation between enjoyment and self-concept, whereby individuals who express enjoyment toward a task, domain, or behavior report increases in aligned self-concepts, receives less attention in achievement motivation literature. For example, some researchers suggest that reciprocal relations between enjoyment and self-concepts can be assumed (Goetz et al., 2008). Marsh and Ayotte (2003) theorize that self-concepts and related affective components such as enjoyment are synchronous, yet conclude that limited investigations explore their reciprocal nature. Pinxten, Marsh, De Fraine, Van Den Noortgate, and Van Damme (2014) represents one of the few studies to explore reciprocal effects of self-concepts and enjoyment in mathematics, revealing that enjoyment led to higher levels of future self-concept with a small effect. However, unlike previous findings self-concept did not lead to higher levels of enjoyment.

Lohbeck, Tietjens, and Bund (2016) reported positive correlations between children's physical self-concept, facets of physical self-concept, and PA enjoyment in a sample of 447 German children. Follow-up regressions revealed that sport and endurance facets of physical self-concept predicted PA enjoyment. Similarly, Scarpa and Nart (2012) found positive correlations between facets of physical self-concept and PA enjoyment. While these correlations results support previous arguments about synchronicity between self-concept and enjoyment (Marsh & Ayotte, 2003), examining relations between dimensions of physical self-concept and PA enjoyment in a longitudinal reciprocal effects model will advance understanding on this topic.

Dynamic systems approaches to emotion assume reciprocal effects, often referred to as feedback loops, between emotions and actions (Fogel et al., 1992; Pekrun, Goetz, Hall, & Perry, 2014). Clear parallels exist between the reciprocal effects model of self-concept and conceptualization of emotions. For example, during school-based interventions, PA enjoyment consistently demonstrates self-enhancing effects on PA behaviors (Dishman et al., 2005) and PA behaviors often predict future reports of PA enjoyment (Salmon, Ball, Hume, Booth, & Crawford, 2008) in youth. Similarly, there are positive associations between changes in enjoyment and changes in PA (Hagberg, Lindahl, Nyberg, & Hellenius, 2009). Kruk et al. (2018) investigated reciprocal effects between PA enjoyment and PA in parent-child dyads from Poland using a seven-to-eight month interval. Evidence supported reciprocal relations for parents, but for children only the PA enjoyment to PA link was present. Taken together, there are clear theoretical and empirical justifications for continued examination of longitudinal relations between physical self-concept and its facets, PA enjoyment, PA enjoyment, and PA in children.

1.4. The present investigation

This study tests a reciprocal effects model of physical self-concept, PA, and PA enjoyment across one school year. Specifically, we investigated the following hypotheses:

Hypothesis 1. (H_1): Children's PA behaviors at the beginning of the school year will predict their future PA enjoyment, physical self-concept and its facets at the end of the year (i.e., skill development hypothesis).

Hypothesis 2. (H_2): Children's PA enjoyment, physical self-concept and its facets at the beginning of the school year will predict their future PA behaviors at the end of the school year (i.e., self-enhancement hypothesis).

Hypothesis 3. (H_3): Children's PA enjoyment and physical self-concept and its facets will demonstrate reciprocal relations across time.

2. Method

2.1. Participants and procedures

Fifth grade students (N = 628) from six elementary schools in the Midwestern United States participated in this study. There were slightly more girls (52%) than boys (48%) and approximately half the students (49%) reported their race/ethnicity as Caucasian or White non-Hispanic. Other race/ethnicities included Black or African American (20%), Asian or Asian American (11%), Hispanic or Mexican American (4%), Arab American (5%), Multi-Racial (6%), American Indian (2%), and Other (3%).

Permission to conduct the study was obtained from the investigators' university institutional review board. Once school administrators gave permission for their school to participate in the research study, one principal investigator visited each school and talked with the 5th grade classroom teachers and students to explain the study. Parents and caregivers received an information sheet about the study and had the ability to opt their child out of the research study. All students provided written assent to participate in the study.

Data were collected during a four-week window at the beginning and end of one school year approximately eight months apart. This timeline is similar to previous research exploring physical self-concept REMs (Garn et al., 2016; Marsh et al., 2006). Data collection at each school occurred over a one-week period. All surveys were read aloud to the students by trained research assistants. Students were encouraged to ask questions if items were unclear. Directions for each survey were read from a standardized script to ensure fidelity across all of the schools. Each survey was given during classroom time and took approximately 30 min to complete.

2.2. Measures

Demographics. The students' self-reported age, sex, birthdate, and race. The items of the survey were read to small groups of the students, as they responded individually on their surveys.

Physical self-concept. Students' physical self-concept and its facets including coordination self-concept, endurance self-concept, flexibility self-concept, health self-concept, sport self-concept, and strength self-concept[1] were measured with the Physical Self-Description Questionnaire–Short (PSDQ-S) developed by Marsh et al. (2010). PSDQ-S items consists of short declarative statement items (e.g., "Physically, I am happy with myself"; "I can run a long way without stopping"; "I am a physically strong person"). Each item is measured on a 6-point scale ranging from False (1) to True (6). The PSDQ-S is one of the most widely used physical self-concept measures and has undergone extensive psychometric testing in adolescents (Marsh et al., 2010) and children of similar age to this sample (Garn et al., 2016). Cronbach alpha estimates were all well above 0.70 in this study: physical self-concept .893 at T1, 0.875 at T2; coordination self-concept .837 at T1, 0.847 at T2; endurance self-concept .803 at T1, 0.791 at T2; flexibility self-concept .867 at T1, 0.900 at T2; health self-concept .796 at T1, 0.800 at T2; sport self-concept .937 at T1, 0.936 at T2; and: strength self-concept .853 at T1, 0.859 at T2.

PA enjoyment. The Physical Activity Enjoyment Scale (PACES) was used to measure children's enjoyment toward PA (Kendzierski & DeCarlo, 1991). The PACES uses the stem "When I am physically active …" and consists of 16 items (e.g., It feels good; It's no fun at all). All items are measured on a 5-point scale ranging from strongly disagree (1) to strongly agree (5). There are nine positively worded and seven negatively worded items. The enjoyment latent construct was originally modeled with all 16 items as individual indicators, and the negatively worded items' loading on a negative method construct. However, the fit of the configural model, and modification indices, revealed correlations also among the positively worded items, such that the 16 items aligned with three parcels: boredom, enjoyment, and energy. This modeling approach resulted in acceptable model fit. The Cronbach alpha estimates were 0.899 at T1 and 0.915 at T2.

PA. PA was measured with the Children's International Physical Activity Questionnaire (IPAQ-C; Crocker, Bailey, Faulkner, Kowalski, & McGrath, 1997; Kowalski, Crocker, & Faulkner, 1997) to assess students' overall physical activity. The IPAQ-C calculations were conducted within Mplus for light, moderate, and vigorous activity as separate parcels, which were then used as indicators for the PA latent construct. The Cronbach alpha estimates were 0.801 at T1 and 0.814 at T2.

2.3. Plan of analysis

Across the full dataset, 83% of the cases had complete data. The data was assessed for normality, and met both univariate and multivariate normality. The missingness was handled by imputation (m = 100) of the full dataset, and with principal component analysis factors as auxiliary variables (Howard, Rhemtulla, & Little, 2015). Imputing the missingness reduces parameter bias, while improving power and generalizability. The imputation conducted in *mice* (van Buuren & Groothuis-Oudshoorn, 2011) was done at the item level and all variable/construct calculations were conducted on the imputed dataset following best practice recommendations (Gottscall, West, & Enders, 2012).

To test the study hypotheses, confirmatory and structural equation modeling analyses were conducted in Mplus 8 (Muthén & Muthén, 1998–2017). The model was a half-longitudinal design, with two groups (i.e., males and females), and utilized the CLUSTER option to account for the natural nesting of students within classrooms. The fixed factor method was utilized and the matching item residuals were correlated with each other across time points. Then, the configural model was run with all the individual indicators loading on their respective constructs, including a negative method factor for the negatively worded items for enjoyment. McDonald's omega was calculated for all the constructs based upon this model with 0.70 as the criterion value, and model fit was assessed using CFI ≥ 0.90, TLI ≥ 0.90, RMSEA ≤ 0.08, and SRMR ≤ 0.08 (Little, 2013).

The positively worded items for enjoyment revealed a correlation pattern supporting two positive characteristics of enjoyment (energy and satisfaction). Thus, the negative method factor was removed, and three parcels (boredom, energy, and satisfaction) were subsequently loaded onto enjoyment. Measurement invariance across factor loadings (i.e., weak invariance: loadings constrained across group and time) and across intercepts (i.e., strong invariance: intercepts constrained across group and time) were examined next. Measurement invariance testing was assessed based upon the nested RMSEA value being within the parent model's RMSEA 90%CI, and a 0.01 or less change in CFI (Little, 2013). Then, homogeneity of latent parameters (i.e., variances, covariances, and means) was tested across group and time. Finally, cross-lag relationships were specified as regression paths, and both within time correlations and cross-lag regressions were tested for significance. All tests of the latent parameters were assessed by the nested model $\Delta\chi^2$ test using a p-value of .005 to adjust for the power of SEM and the study sample size.

3. Results

The relative efficiency values (0.994-0.998) of the variables in the model supported the number of imputations conducted (Rhemtulla, Savalei, & Little, 2016). Table 1 presents latent correlation and coefficient omega reliability estimates. The configural model with two groups

Table 1
Latent correlation and coefficient omega reliability estimates.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1. Coordination SC	.84, .84																	
2. Flexibility SC	.49	.85, .89																
3. Endurance SC	.75	.46	.86, .79															
4. Sport SC	.68	.38	.66	.95, .92														
5. Strength SC	.65	.39	.67	.73	.89, .82													
6. Health SC	.29	.08	.21	.18	.22	.78, .82												
7. Global SC	.58	.35	.58	.59	.61	.23	.89, .90											
8. PA Enjoyment	.56	.29	.54	.49	.44	.25	.43	.91, .90										
9. PA Subjective	.55	.34	.61	.55	.52	.16	.43	.57	.79, .83									
10. Coordination SC T2	.60	.40	.52	.51	.52	.14	.43	.39	.38	.87, .83								
11. Flexibility SC T2	.35	.73	.37	.35	.35	.07	.32	.22	.29	.49	.88, .91							
12. Endurance SC T2	.50	.32	.62	.50	.53	.16	.42	.34	.47	.75	.46	.83, .78						
13. Sport SC T2	.50	.29	.47	.66	.54	.09	.40	.38	.45	.68	.38	.66	.94, .93					
14. Strength SC T2	.42	.32	.49	.48	.64	.08	.34	.30	.43	.65	.39	.67	.73	.89, .84				
15. Health SC T2	.22	.10	.21	.17	.17	.40	.13	.11	.07	.29	.08	.21	.18	.22	.79, .81			
16. Global SC T2	.41	.27	.45	.40	.40	.14	.54	.28	.38	.58	.35	.58	.59	.61	.23	.91, .84		
17. PA Enjoyment T2	.46	.28	.48	.44	.38	.17	.38	.58	.45	.56	.29	.54	.49	.44	.25	.43	.92, .91	
18. PA Subjective T2	.41	.32	.49	.50	.42	.09	.31	.36	.62	.55	.34	.61	.55	.52	.16	.43	.57	.82, .77

Note. Bold designates significance p ≤ .005. Correlations are from the homogeneity of variances and covariances model. Along the diagonal are the McDonald's omega reliability coefficient values (males, females) based upon the configural model with all the items (prior to parceling). SC = self-concept; PA = physical activity; T2 = time two.

Table 2
Standardized factor loadings (λ), residuals (δ), and accounted variance (h^2) for males and females.

Parameter Estimate	Male Time 1			Female Time 1			Male Time 2			Female Time 2		
	λ	δ	h2	λ	δ	h2	λ	δ	h2	λ	δ	h2
Coordination Item 1	0.631	0.602	0.398	0.600	0.640	0.360	0.728	0.470	0.530	0.726	0.473	0.527
Coordination Item 2	0.569	0.676	0.324	0.532	0.717	0.283	0.670	0.551	0.449	0.634	0.598	0.402
Coordination Item 3	0.792	0.373	0.627	0.745	0.445	0.555	0.817	0.333	0.667	0.771	0.406	0.594
Coordination Item 4	0.752	0.434	0.566	0.697	0.514	0.486	0.813	0.339	0.661	0.750	0.438	0.563
Coordination Item 5	0.726	0.473	0.527	0.719	0.483	0.517	0.759	0.424	0.576	0.727	0.471	0.529
Flexibility Item 1	0.665	0.558	0.442	0.731	0.466	0.534	0.771	0.406	0.594	0.825	0.319	0.681
Flexibility Item 2	0.845	0.286	0.714	0.858	0.264	0.736	0.896	0.197	0.803	0.935	0.126	0.874
Flexibility Item 3	0.816	0.334	0.666	0.841	0.293	0.707	0.893	0.203	0.797	0.892	0.204	0.796
Endurance Item 1	0.809	0.346	0.654	0.729	0.469	0.531	0.817	0.333	0.667	0.768	0.410	0.590
Endurance Item 2	0.813	0.339	0.661	0.768	0.410	0.590	0.847	0.283	0.717	0.819	0.329	0.671
Endurance Item 3	0.653	0.574	0.426	0.614	0.623	0.377	0.671	0.550	0.450	0.676	0.543	0.457
Sport Item 1	0.937	0.122	0.878	0.847	0.283	0.717	0.930	0.135	0.865	0.897	0.195	0.805
Sport Item 2	0.900	0.190	0.810	0.861	0.259	0.741	0.926	0.143	0.857	0.909	0.174	0.826
Sport Item 3	0.910	0.172	0.828	0.877	0.231	0.769	0.937	0.122	0.878	0.917	0.159	0.841
Strength Item 1	0.821	0.326	0.674	0.801	0.358	0.642	0.896	0.197	0.803	0.855	0.269	0.731
Strength Item 2	0.755	0.430	0.570	0.748	0.440	0.560	0.835	0.303	0.697	0.779	0.393	0.607
Strength Item 3	0.822	0.324	0.676	0.743	0.448	0.552	0.850	0.278	0.723	0.806	0.350	0.650
Health Item 1	0.633	0.599	0.401	0.587	0.655	0.345	0.701	0.509	0.491	0.672	0.548	0.452
Health Item 2	0.612	0.625	0.375	0.715	0.489	0.511	0.734	0.461	0.539	0.730	0.467	0.533
Health Item 3	0.758	0.425	0.575	0.730	0.467	0.533	0.795	0.368	0.632	0.832	0.308	0.692
Health Item 4	0.609	0.629	0.371	0.606	0.633	0.367	0.594	0.647	0.353	0.601	0.639	0.361
Health Item 5	0.639	0.592	0.408	0.597	0.644	0.356	0.630	0.603	0.397	0.584	0.659	0.341
Global Item 1	0.879	0.227	0.773	0.892	0.204	0.796	0.920	0.154	0.846	0.853	0.272	0.728
Global Item 2	0.909	0.174	0.826	0.871	0.241	0.759	0.922	0.150	0.850	0.866	0.250	0.750
Global Item 3	0.725	0.474	0.526	0.778	0.395	0.605	0.787	0.381	0.619	0.772	0.404	0.596
Enjoyment Parcel	0.890	0.208	0.792	0.864	0.254	0.746	0.935	0.126	0.874	0.911	0.170	0.830
Boredom Parcel	0.731	0.466	0.534	0.714	0.490	0.510	0.833	0.306	0.694	0.798	0.363	0.637
Energy Parcel	0.785	0.384	0.616	0.772	0.404	0.596	0.857	0.266	0.734	0.825	0.319	0.681
IPAQ Item 1	0.473	0.776	0.224	0.592	0.650	0.350	0.519	0.731	0.269	0.558	0.689	0.311
IPAQ Item 2	0.731	0.466	0.534	0.747	0.442	0.558	0.811	0.342	0.658	0.790	0.376	0.624
IPAQ Item 3	0.796	0.366	0.634	0.809	0.346	0.654	0.844	0.288	0.712	0.819	0.329	0.671

Note. Global = global physical self-concept; IPAQ = International Physical Activity Questionnaire. All factor loadings, $p < .001$

(i.e., male and female) did not have acceptable model fit (χ^2_{7588} = 13909.410, CFI = .80, TLI = .78, SRMR = .072, RMSEA = .051, SD = .001). Examining the model parameter estimates and the modification indices, revealed a residual correlation pattern between the enjoyment items that supported parceling the items into three parcels: satisfaction, energy, and boredom. This configural model fit the data well (χ^2_{3290} = 5502.00, CFI = .961, TLI = .954, SRMR = .047, RMSEA = .046, SD = .002). The factor loadings, residuals, and communalities are presented in Table 2. Weak invariance and strong invariance across both group and time were each passed (see Table 3). This supported that the constructs were similarly measured across group and time, and so comparable.

The homogeneity of latent variances was tested next and passed across both group and time ($\Delta\chi^2_{27}$ = 27.161, p = .455). This revealed that the variability of the constructs was not moderated by gender or time. Moreover, the relationships between the constructs was not moderated by gender or time ($\Delta\chi^2_{189}$ = 220.64, p = .057). The latent means omnibus test for homogeneity was not tenable ($\Delta\chi^2_{24}$ = 100.43, $p < .001$). The means were constrainable across time for the male and female groups, separately, however, three means were not constrainable across gender, as well. The male and female groups' subjective PA, global physical self-concept, and flexibility self-concept latent means were significantly different from each other (see Figure 1). Specifically, the females' subjective PA at T1 (M = 2.73 ± 1.06) and T2 (M = 2.76 ± 1.07) was significantly lower than the males' subjective PA at T1 (M = 2.97 ± 1.00) and T2 (M = 2.99 ± 1.08). Also, the females' global physical self-concept at T1 (M = 5.23 ± .99) and T2 (M = 5.20 ± .92) was significantly different from the males' global physical self-concept at T1 (M = 5.24 ± 1.00) and T2 (M = 5.19 ± 1.07). Lastly, the females' flexibility self-concept was significantly higher at T1 (M = 4.38 ± 1.07) and T2 (M = 4.47 ± 1.08) than the males' flexibility self-concept at T1 (M = 3.97 ± 1.00) and T2 (M = 3.83 ± 1.05).

Finally, the regression paths were tested for significance (see Figure 1). The eight autoregressive paths were all significant ($p < .001$). Five cross-lag paths were significant ($p \leq .001$). T1 coordination self-concept significantly predicted PA enjoyment (β = .16, $p < .001$) after controlling for T1 PA enjoyment. T1 strength self-concept significantly predicted T2 endurance self-concept (β = .17, $p < .001$) after controlling for T1 values. T1 sport self-concept significantly predicted T2 subjective PA (β = .18, $p < .001$) after controlling for T1 values. T1 PA enjoyment predicted T1 sport self-concept (β = .08, $p < .001$) after controlling for T1 values. Finally, T1 subjective PA significantly predicted global physical self-concept after controlling for T1 values (β = .11, p = .001). The model accounted for the following percentages of variance of each T2 construct: 25% coordination self-concept, 34% flexibility self-concept, 25% endurance self-concept, 22% strength self-concept, 26% sport self-concept, 14% health self-concept, 21% global physical self-concept, 27% PA enjoyment, and 24% subjective PA.

Table 3
Model Fit Values for Measurement Invariance Testing and Structural Model Testing.

Model Description	Replications Completed		df	CFI	NNFI	SRMR	RMSEA	RMSEA SD	ΔCFI			p-value (.005 sig)	*Tenable? Pass?*
Configural Model with items for McDonald's omega	100/100	13909.41	7588	0.800	0.784	0.072	0.051	0.001					Yes
Configural Model with parcels	100/100	5502.00	3290	0.961	0.954	0.047	0.046	0.002					Yes
Weak invariance model	100/100	5552.05	3356	0.961	0.955	0.051	0.046	0.002	0.000				Yes
Strong invariance model	100/100	5736.11	3422	0.959	0.954	0.052	0.046	0.002	0.002				Yes
Omnibus homogeneity of variances model	100/100	5763.27	3449	0.959	0.954	0.073	0.045	0.002		27.16	27	0.455	Yes
Omnibus homogeneity of covariances model	100/100	6080.64	3638	0.957	0.954	0.095	0.046	0.002		317.37	189	< .001	No
Revised homogeneity of covariances model	100/100	5829.76	3512	0.959	0.955	0.062	0.046	0.002		66.49	63	0.358	Yes
Omnibus homogeneity of latent means model	100/100	5863.7	3476	0.958	0.953	0.074	0.045	0.002		100.43	27	< .001	No
Revised homogeneity of latent means model	100/100	5798.48	3473	0.959	0.950	0.059	0.046	0.002		35.21	24	0.006	Yes
Baseline Regression model	100/100	6072.64	3638	0.957	0.954	0.093	0.046	0.002					
Final Regression Model	100/100	6178.36	3706	0.956	0.955	0.098	0.046	0.022		105.72	230	0.007	Yes

Note. χ^2 = chi-square value; df = degrees of freedom; CFI = Comparative Fit Index; NNFI = Non-normed Fit Index; SRMR = standardized root mean square residuals; RMSEA = root mean square error of approximation; SD = standard deviation; Δ = change

4. Discussion

The purpose of this study was to investigate a reciprocal effects model of physical self-concept, PA enjoyment, and PA with a sample of elementary students in grade 5. This is the first physical self-concept study to include emotion within the reciprocal effects model, which reflects self-concept research in other domains (Goetz et al., 2008). Emotions and self-concept are both important aspects of children's well-being that are also considered behavioral determinants of PA (Dishman et al., 2005; Garn et al., 2016; Lindwall et al., 2014; Marsh et al., 2006).

The skill development hypothesis (H_1) infers that self-concepts are a consequence of achievement (Calysn & Kenny, 1977) including engagement in health-related PA (Lindwall et al., 2014; Marsh et al., 2006; Sonstroem et al., 1994). Findings provided partial support for H_1. Specifically, T1 PA predicted T2 physical self-concept controlling for physical self-concept at T1. This finding supports previous physical self-concept research that highlights support for the skill development hypothesis when examining the reciprocal effects model of physical self-concept and self-reported PA in youth (Lindwall et al., 2014; Marsh et al., 2006; Trautwein et al., 2008). However, not all physical self-concept REMs support the skill development hypothesis. For example, Lemoyne et al. (2015) reported no skill development effects in a Canadian sample of college students over a three-month period. It should also be noted that unlike some previous findings (Asci, 2003; Lindwall et al., 2014), T1 PA did not predict any facets of physical self-concept (e.g., coordination self-concept; endurance self-concept, health self-concept, etc.) at T2. It is possible that measuring type of PA may be especially important to understanding relationships with specific facets of physical self-concept (Lemoyne et al. 2015). Specifically, examining the type of PA such as engagement in strength training activities may increase the likelihood to detect skill development effects in matching facets of physical self-concept (i.e., strength self-concept).

The self-enhancement hypothesis (H_2) suggests that higher self-concepts lead to future achievements (Calysn & Kenny, 1977) including engagement in PA (Marsh et al., 2006). In this study, there was only partial support of self-enhancement effects. Specifically, children's sport self-concept predicted future self-reported PA while controlling for previous levels of self-reported PA. However, neither physical self-concept nor any of its facets besides sport self-concept were predictors of future subjective PA and there were no relations between T1 physical self-concept and its facets and the T2 objectively measured PA. It is possible that children's sport self-concept plays a larger role on future PA outside of school because they have more opportunities to engage in structured and non-structured sports. Nevertheless, the connection between sport self-concept and future self-reported PA underscores the notion that positive self-concept contributes to more PA behavioral engagement (Craven & Marsh, 2008; Lindwall et al., 2014; Marsh et al., 2006).

Findings across H_1 and H_2 did not support reciprocal effects between any specific aspects of physical self-concept and PA. Instead, a skill development effect related to global physical self-concept, while a self-enhancement effect related to the sport facet of physical self-concept. It is possible that the period between measurement points changes the nature of skill development and self-enhancing effects. Currently the ideal amount of time to capture these effects is unclear. Finally, the age of these children may have influenced findings related to H_1 and H_2. Harter (2012) suggests that self-concepts become more realistic as children transition into adolescence. Thus, unrealistic or inflated physical self-concept, or facets of physical self-concept, may degrade skill development and self-enhancing effects.

There was no support for H_3, reciprocal effects (Fogel et al., 1992) between PA and PA enjoyment or physical self-concept and PA enjoyment. There were only two cross-lagged links: (a) coordination self-concept at T1 predicted PA enjoyment at T2; and (b) PA enjoyment at T1 predicted sport self-concept at T2. The lack of support for H_3 was surprising because evidence supports PA enjoyment as an important

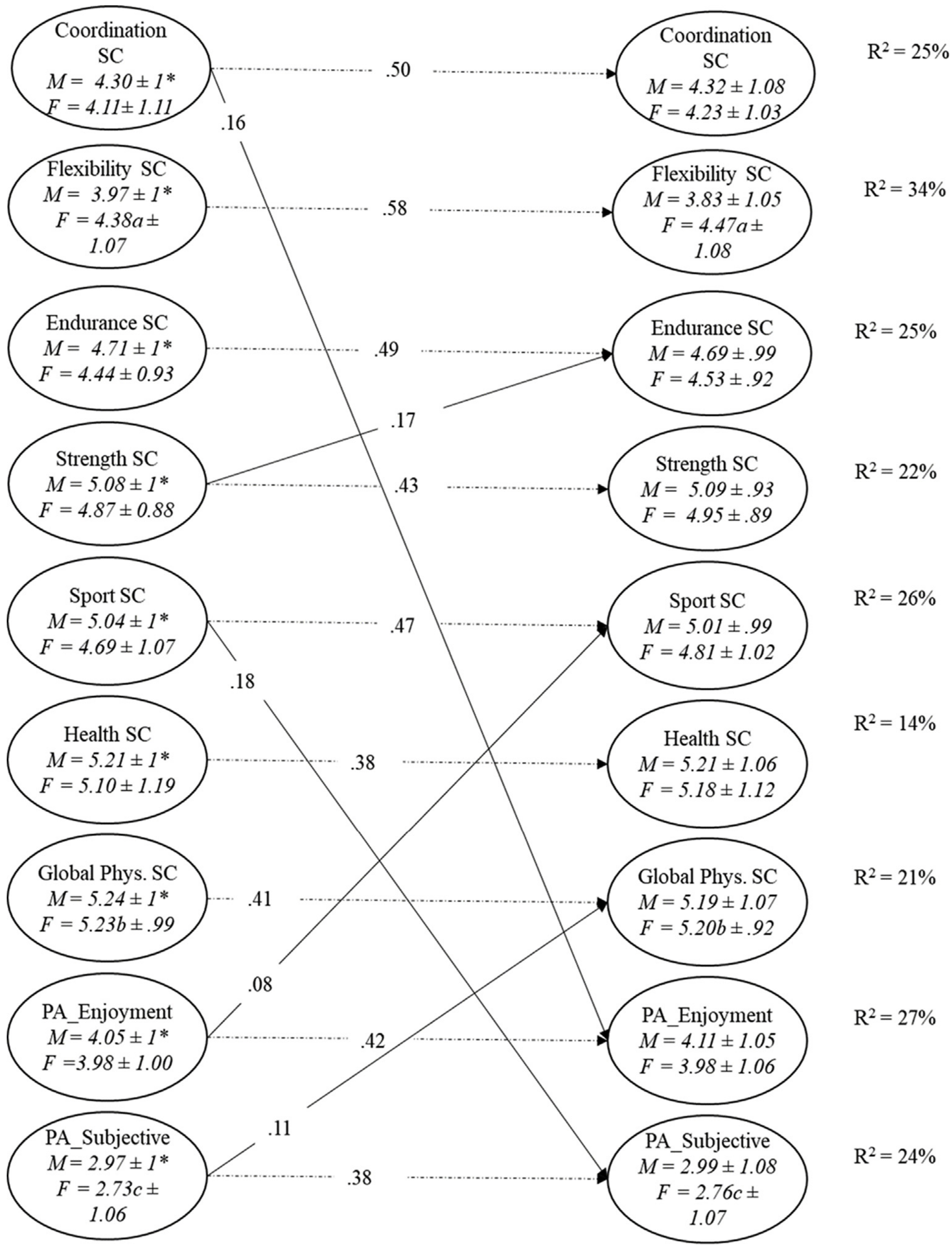

Fig. 1. Only Time 2 latent mean values for females' Flexibility self-concept (SC), Global Physical SC, and Subjective PA were significantly different by gender; all other means were constrainable across both gender and time. The significant ($p \leq .005$), standardized regression coefficients are shown in the figure. All correlation and regression values were constrainable across time and gender (i.e., none of these relationship values were significantly moderated by group membership or time period). The fit for this model was: (χ^2_{3706} = 6178.36,CFI = .956, NNFI = .955, SRMR = .098, RMSEA = .046 ± 0.002).

correlate of PA in youth (Dishman et al., 2005; Kavanaugh, Moore, Hibbett, & Kaczynski, 2015). It should be noted that cross-sectional correlations between PA enjoyment and self-reported PA were substantive (r = .50 - 0.60), which reinforces the relationship contrasts that can occur between cross-sectional and longitudinal designs (Little, 2013). Again, the time interval may also play a role in understanding the longitudinal relationships between physical self-concept and PA enjoyment. For example, Pinxten et al. (2014) failed to detect reciprocal relationships between enjoyment and self-concept in mathematics using one-year intervals. In this study, we used 8-month intervals. Future researchers should determine if the interplay between self-concept and enjoyment is more evident when using shorter measurement cycles.

Finally, it is also possible that physical self-concept and its facets, PA enjoyment, and PA relationships are more complex than we hypothesized. Closer inspection of our results highlight links between PA enjoyment to future sport self-concept, and sport self-concept to future PA. Therefore, future research examining a PA enjoyment → sport self-concept → PA mediation model across a minimum of three waves of data could potentially help sort out these temporal dynamics (Cole & Maxwell, 2003).

4.1. Limitations and future research

This study is not without limitations, for example, participants represented students in grade 5 from a single region in the United States. We caution readers to keep this in mind when generalizing findings and encourage future research with more diverse school populations. Another limitation was using a self-report measure of PA, which can suffer from bias and challenge children's recall abilities. Almost all physical self-concept and PA REM studies have relied on self-report measures of PA (Lemoyne et al., 2015; Lindwall et al., 2014; Marsh et al., 2006; Trautwein et al., 2008). A stronger measurement approach in future research would be investigating seven days of PA with accelerometers both in and out of school. Similarly, using direct observation measures of PA in physical self-concept REMs would provide more context on the matching PA types (e.g., sport participation) with physical self-concept facets (e.g., sport self-concept) devised by Lemoyne et al. (2015).

Longitudinal designs that include more than two time points is also needed in future reciprocal effects model research and can be considered a limitation of this study. Furthermore, a greater number of time points would enhance options for investigating the reciprocal effects model. The implementation of three or more waves of data would also allow self-concept researchers to investigate within-person associations between PA, physical self-concept, and PA enjoyment, which could be useful in developing effective intervention strategies for improving children's health (Lindwall et al., 2014). We did not use appearance related facets of physical self-concept based on objections from some of the school administrators, which is also a limitation. From a developmental perspective, examining children's veridicality rather than overall level of self-concept may be advantageous in future research (Schmidt et al., 2013). Veridicality represents the alignment between one's self-beliefs and actual abilities and skills. Accurate self-concepts (i.e., high veridicality) often produce stronger relations with matching achievement, behaviors, and skills (Weiss & Horn, 1990). Veridicality may be especially important in children because they tend to overestimate self-concepts (Harter, 2012).

5. Conclusions

We tested a reciprocal effects model of physical self-concept and its facets, PA enjoyment, and subjective PA. Findings revealed an inconsistent set of longitudinal relationships that provided partial support for skill development and self-enhancement hypotheses, but minimal support for feedback loops with PA enjoyment. It should be noted that while boys' levels of PA were slightly higher than girls' levels of PA, all relationships tested in this study were consistent for boys and girls. Sport self-concept was an important facet of these students' physical self-concept. It was the only aspect of physical self-concept associated with future levels of PA (i.e., self-enhancing effects). Furthermore, PA enjoyment was associated with higher reports of future sport self-concept. More investigation targeting children's sport self-concept can help determine its effectiveness in promoting children's engagement in and enjoyment toward PA.

Conflicts of interest

Support for this project was generously provided by Blue Cross Blue Shield of Michigan, the Michigan Department of Health and Human Services, Gopher Sports, Food Corp, and the United Dairy Industry of Michigan. The authors perceive no conflicts of interest with these funding sources.

This manuscript represents results of original work that have not been published elsewhere. This manuscript is not part of a larger study. Furthermore, this manuscript has not and will not be submitted for publication elsewhere until a decision is made regarding the acceptability for publication in *Psychology of Sport and Exercise*. If accepted for publication, it will not be published elsewhere. There are no perceived financial conflicts of interest related to the research reported in the manuscript. All authors acknowledge ethical responsibility for the content of the manuscript and will accept the consequences of any ethical violation.

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