The Physical Self in Motion:

Within-Person Change and Associations of Change in Self-Esteem, Physical Self-Concept and Physical Activity in Adolescent Girls

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Abstract

The purpose of this study was to examine patterns of within-person change, and associations of change, in global self-esteem (GSE), physical self-perceptions (PSP) and physical activity in a sample of 705 Canadian adolescent girls over three measurements points and 24 months. The Physical Self-Perceptions Profile (PSPP) was used to measure GSE and PSP and the Physical Activity Questionnaire for Adolescents (PAQ-A) was used to assess physical activity. Latent growth curve models were used to analyse the data. All PSP variables except for body attractiveness demonstrated significant average decline but also significant was the change in between-person heterogeneity. Change in GSE and PSP was moderately to strongly related on a between-person level and weakly to moderately associated on a within-person level. Change in physical activity was related to change in the majority of the PSP variables but not to change in GSE.

Key words: change, latent growth curve, physical self-perceptions, physical activity, self-esteem

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Physical self-esteem, and physical self-perceptions (PSP) are considered to be important psychological constructs in adolescents' overall self-esteem (Crocker, Kowalski, & Hadd, 2008; Fox, 2000). According to Fox (2000), "the physical self-esteem has occupied a unique position in the self-esteem system because the body, through its appearance, attributes, and abilities, provides the substantive interface between the individual and the world" (pp.230). Indeed, the highly valued perception of physical self-esteem has emerged as particularly important to global self-esteem development (Orth, Robins & Widaman, 2012).

Research in the area of physical self-esteem has drawn heavily from multidimensional and hierarchical models of the self (Fox, 1990; Marsh & Craven, 2006). In the hypothesised hierarchical model, global self-esteem (GSE) is placed as a superordinate domain above more specific but global domains—such as physical self-worth (PSW)—which, in turn, are hierarchically above the more differentiated PSP subdomains, such as sports competence, body attractiveness, physical strength and physical conditioning. These PSP subdomains are viewed as specific and more changeable aspects of the self, with perceptions becoming more general and enduring in the higher the level of the hierarchy (Fox, 1997). Physical self-esteem has been shown to be the self-domain with a major influence on, or shared the greatest overlap with, GSE (e.g., Harter, 2012). Previous work (e.g., Lindwall, Asci, Palmeira, Fox & Hagger, 2011) has also supported the tenants of the hierarchical multidimensional model, showing stronger relationships between GSE and PSW compared to relationships between GSE and subdomains of PSP situated lower down in the model. Multidimensional and hierarchical models also hold that PSP should share more variance with PSW than with GSE. Of the four subdomains of physical self-perceptions, body attractiveness is reported to be the most strongly related factor to both PSW and GSE (see Crocker et al., 2008; Fox, 1997;

Lindwall et al., 2011). Associations between GSE and the other three domains of PSP have generally been found to be low to moderate in strength (*r* =.15-.40). The results of previous work, however, are based mostly on cross-sectional studies. Although some prospective studies have examined predictions across time (e.g., Crocker et al., 2006; Kowalski et al., 2003), little is known about how parallel within-person change in the physical-self and GSE are related across time, consequently leaving a gap in our knowledge of the validity of the hierarchical model in terms of dynamic changes.

The relationships among GSE, PSP, and physical activity have been examined in terms of self-enhancement and skill development hypotheses (e.g., Calsyn & Kenny, 1977; Sonstroem, 1998). From self-enhancement perspectives (suggesting that more positive self-perceptions lead to more engagement in physical activity) previous studies on adolescents (e.g., Çağlar & Aşçı, 2006; Lindwall & Hassmen, 2004) have consistently reported that individuals with higher (more positive) PSP were more physically active. From a skill development hypothesis (proposing that physical activity leads to enhanced self-perceptions), studies have reported the positive effects of different exercise interventions on physical self-esteem (e.g. Aşçı, 2003; Lindwall & Lindgren, 2005). In general, physical activity demonstrated stronger relationships with PSP compared to GSE (e.g., Crocker et al., 2008). Meta-analyses (Spence, McGannon, & Poon, 2005) and reviews (Crocker et al., 2008; Fox, 2000) of intervention-studies have suggested that the effect of exercise on GSE was significant but small, whereas more robust effects were expected on almost all subdomains of the physical-self (with the exception of body attractiveness). Again, few previous studies have examined the relationships of change in these concepts, in particular, from a within-person level of analysis.

In developmental sport and exercise psychology, the concept of change is a central theme in many theories. This is also the case when it comes to PSP and GSE (Horn, 2004).

The majority of previous longitudinal studies (e.g., Crocker et al., 2006; Kowalski et al., 2003; Slutzky & Simpkins, 2009) targeting associations of GSE, PSP, and physical activity have used analytical approaches according to a *launch model of developmental change* (Skinner, Zimmer-Gembeck & Connell, 1998), assuming that change in a variable (e.g., GSE) is a function of initial starting levels of other variables/predictors (e.g., physical activity, PSP). An alternative model to the launch model is the *change-to-change model*, in which change in one variable is a function of change (not only level) in another. Because the change-to-change model targets associations of changes between variables, this model is particularly relevant and useful when the target variables are believed to demonstrate change and fluctuations rather than stability (Skinner et al., 1998).

Longitudinal studies show that self-evaluations on a more general level (e.g., GSE) demonstrate substantial change during adolescence (e.g., Baldwin & Hoffmann, 2002; Robins et al., 2002) and are not typically stable. Normative changes in GSE (Robins et al., 2002) across adolescence are best described as a U-form shape with GSE generally declining throughout early and middle adolescence (from previously relatively high levels in late childhood) to increase again in late adolescence. Studies have also demonstrated that change in GSE across adolescence is more dramatic in females than in males (Baldwin & Hoffmann, 2002), pointing to the particular value of understanding GSE change and associations of change in girls. Other studies have shown that the physical-self remains relatively stable across time (Crocker et al., 2006, Kowalski et al., 2003). In fact, it has been suggested that PSP may be even more stable across time compared with the higher order factor of GSE (Amorose, 2001; Marsh & Yeung, 1998), contradicting one of the key assumptions of the original multidimensional hierarchical model of the self (Shavelson, Hubner & Stanton, 1976). The aforementioned studies on the physical-self (with a notable exception of Amorose, 2001), however, have used analyses (e.g., cross-lagged panel models) that are more consistent with the launch model of development, focusing on predictions across time (controlling for previous level) rather than change (within-person change in particular) and associations of change, which are central aspects in the change-to-change model. Despite being called for by several scholars in previous works (e.g., Fredricks & Eccles, 2002; Skinner et al., 1998), surprisingly few studies have adopted a change-to-change model of development to examine trajectories and patterns of change in adolescents' GSE and physical self-perceptions over time, and how these changes are linked to changes in health related behaviors such as physical activity.

Strong longitudinal designs with multiple measurement times and appropriate analytical models are needed to properly address intra-individual change and the complex questions of the associations of change. Such designs and analytical approaches have been called for in the field of developmental sport and exercise psychology (e.g., Schutz & Park, 2004). Latent growth curve models (LGCM) (Duncan et al., 2006; Meredith & Tisak, 1990; Willett & Sayer, 1994) are examples of such approaches that are appropriate for the purpose of targeting true within-person change. One advantage with these models is that they not only describe any single individual's developmental trajectories across time, but also take into consideration inter-individual (between-person) differences in these intra-individual trajectories. Moreover, multivariate growth curve models are especially relevant to use when examining associations of change between variables, both from a more traditional between-person perspective (e.g., if a person changes in physical activity, relative to others, does he or she also change, relative to others, in GSE?) and from a within-person perspective (e.g., if a person deviates from, is higher or lower than, the expected curve in physical activity at a specific time-point, will he or she also be higher or lower than expected in GSE at that point in time?). Despite its significance, these central questions have rarely been targeted in developmental sport and exercise psychology, and to our best knowledge, never linked to GSE, PSP, and physical activity. One study that addressed similar questions and used more advanced change analyses to examine longitudinal associations of change between adolescents' GSE and one of the PSP subdomains (body image), was conducted by Morin and colleagues (Morin, Maïano, Marsh, Janosz, & Nagengast, 2011). The study involved over 1,000 adolescents across six time-points. Aside from using LGCM, targeting parallel associations of change, the study introduced autoregressive latent curve models (ALT) that afford the possibility of addressing both intra-individual change (or lack thereof) and the nature and direction of effects between GSE and body image across time (e.g., does GSE influence subsequent body-image, the reverse, or both?). These procedures allowed the examination of both trait-like and state-like relationships. The findings indicated that both GSE and body-image were characterised by intra-individual stability and that state-like levels of GSE were positively influenced by state-like levels of body-image, supporting a bottom-up hypothesis where lower-order constructs (e.g., body-image) affect higher order constructs, such as GSE. Although Morin et al. used similar change models to those used in the present study, only one PSP domain (body image) was linked to change in GSE. In the present study we extend the pursuit of Morin et al. by examining the link between multiple dimensions of PSP and GSE, apart from also including physical activity.

The purpose of this study was to examine patterns of within-person (intra-individual) change in GSE, PSP and physical activity in a sample of Canadian adolescent girls over three measurements points and 24 months, and more specifically, to examine the associations of within-person change in these variables over time.

Methods

Participants

Data from the study have previously been published, (e.g., Crocker et al., 2006), but these previous studies did not focus on change associations using LGCM. Participants were

705 female adolescents involved in the 3-year longitudinal study on physical self-perceptions and health behavior. In the first year (term one, 1998/99 school year), 705 grade nine female students (14–15 years old) participated, representing a range of socioeconomic backgrounds from Saskatoon, Saskatchewan (Canada) and the surrounding rural and urban areas. Of the beginning sample, 501 participants provided full data for all 3 years. The analyses of the present study, however, were based on all 705 participants that participated from the start (see Analyses section below).

Measures

Global self-esteem and physical self-perceptions. The Physical Self-Perceptions Profile (PSPP; Fox & Corbin, 1989) consists of five 6-item scales that measure perceptions of physical self-worth (PSW), sport competence (Sport), body attractiveness (Body), physical conditioning and exercise (Cond), and physical strength and muscular development (Strength). The item score can range from 1 (low) to 4 (high) on a structured-alternative scale. Scores from the PSPP scales have demonstrated acceptable scale reliability and validity with older children and adolescents (Crocker, Eklund, & Kowalski, 2000). The reliability of the PSPP scales in this study across the three time points were Sport (α = .89 /.91/.89), Strength (α .88 /.91/.89), Cond (α = .87 /.89/.88), Body (α = .89 /.91/.89), and PSW (α = .90 /.91/.89). The "What I am Like" Questionnaire from the Adolescent Self-Perception Profile assessed global self-esteem/worth (GSE). The GSE is a five-item self-report questionnaire recommended for use with adolescents (Harter, 1988). In the present study the reliability of the GSE across the three time points was α = .86/ .86 /.84.

Physical Activity. The Physical Activity Questionnaire for Adolescents (PAQ-A; Kowalski, Crocker, & Kowalski, 1997) is an 8-item self-report seven-day activity questionnaire. Each item is scored on a 5-point Likert scale, with higher scores indicating greater physical activity levels. Scores from the PAQ-A have demonstrated acceptable concurrent validity with other measures of physical activity (Kowalski et al., 2003). In the present study, the reliability estimates across the three time points for the PAQ-A were α = .79/ .81 /.80.

Procedure

Following approval from the university and participating school ethics boards and school principals, researchers met with the students to describe the study and distribute consent forms. One week later the questionnaire package was administered during class time, with a researcher available to answer any questions. Approximately one year later, data were collected using the same procedures, which were again followed in the third year.

Analyses

We used latent growth curve models (LGCM), which are a specific case of mixed or random effects models (Meredith & Tisak, 1990; Willett & Sayer, 1994), to analyse patterns of change and associations of change between GSE, physical self-perceptions, and physical activity. Compared with traditional methods of analysing longitudinal data (e.g., general linear models), LGCM hold a number of advantages (Duncan et al., 2006). For example, they may answer different questions concerning the concept of change, and in particular, associations of change among variables. In LGCM within the structural equation modelling framework, observed repeated measures across time are used as indicators of unobserved (latent), underlying, true growth trajectory factors (Duncan, et al., 2006). Hence, LGCM include a powerful and flexible methodology with which to model intra-individual changes, inter-individual differences in intra-individual change, and how level and true change are related.

In the present study, we also used multivariate LGCM to estimate the co-variation of individual differences in GSE, physical self-perceptions and physical activity in: a) initial status at baseline (intercept), b) linear rate of change (slope) and, c) systematic occasion specific deviations (residuals, or within-person correlations). LGCM were fit to data using Mplus (version 7.1, Muthen & Muthen, 1998-2012) with a robust maximum likelihood estimator. To handle missing data (Enders, 2010; Graham, 2009), we used Full Information Maximum Likelihood estimation (FIML). The baseline univariate model contained a latent factor of mean level (e.g., sample average initial value of global self-esteem at baseline), a latent factor of mean linear change (e.g., sample average change trajectories in global self-esteem across the three measurement points), a latent factor of variance of level (e.g., inter-individual differences in global self-esteem at baseline), and a latent factor of variance in rate of linear change (e.g., inter-individual differences in global self-esteem change). No quadratic slope was estimated due to the fact that four measurement occasions would be needed to model mean and variance of quadratic slope. The loadings of the three time points for the slope were set to 0, 1, and 2. The covariance between level and change was also modelled. We first ran one univariate LGCM for each of the main variables to examine fixed effects estimates of intercept (average starting point at baseline), slope (average change) as well as random effects estimates of intercept (interindividual differences in starting point at baseline) and slope (inter-individual difference in change). In the multivariate LGCM, we examined covariation between: a) intercepts (correlation at baseline), b) slopes (correlated change), and c) occasion specific residuals (coupled change) in global self-esteem, physical self-perceptions and physical activity. The slope-slope correlations, the correlated change, may be interpreted as the extent to which within-person trajectories of, for example, GSE and physical activity are related between persons across the measurement points. The correlation between occasion specific residuals, on the other hand, reflects within-person correlations and answers the question: Are state-like fluctuations at each measurement time in, for example, GSE, associated with similar fluctuations at each time in, for example, physical activity? The following fit indices were used: (a) chi-square statistics, (b) Bentler's comparative fit index

(CFI, (c) the Tucker-Lewis Index (TLI), and (d) the root mean square error of approximation (RMSEA). For CFI and TLI, values close to .95 or greater indicate a well-fitting model whereas values of .06 and less for the RMSEA indicate a good model-data fit (Hu & Bentler, 1999).

Results

Within-Person Change in Self-Esteem, Physical Self-Perceptions and Physical Activity

Descriptions of average starting point at baseline (intercept mean) and within-person change (slope mean), and, estimates of between-person differences in starting point (intercept variance) and within-person change (slope variance), are described in Table 1 ,which includes the correlation between starting point and change. Also, R^2 for the three measurements for each variable is also presented, yielding information on the proportion of variance in the time-repeated measures that are explained by the model. The univariate LGCM fitted the data well for all variables, indicated by non-significant chi-square values and high (i.e., > .98) CFI and TLI values (for model fit indices of each model, see Table 3 in the online supplemental material). The only model that did not display non-significant chi-square values was PSW ($p = .05$). Nevertheless, the CFI and TLI values (> .99) still suggested that this model made an acceptable fit to the data. Also, the R^2 values for the three repeated measures of each variable were generally high, indicating that the model explained a large proportion of the variance in the measures.

Looking at fixed effects (average means), GSE did not reveal any average change, as indicated by the non-significant mean slope estimates ($\mu_s = 0.01$, $p > .05$). All physical self-perception variables, aside from Body, revealed a significant average decrease ($\mu_s = -0.09$ to -0.03, *p*s < .01). Body, on the other hand, demonstrated a significant increase ($\mu_s = 0.04$, $p < .01$). Physical activity also displayed an average significant decrease ($\mu_s = -0.22$, $p < .01$).

In terms of random effects there was significant between-person heterogeneity at starting point (intercept variance) for all variables ($\sigma^2_{iGSE} = 0.36$, $p < .01$; $\sigma^2_{iPSW} = 0.39$, $p < .01$; $\sigma^2_{iBody} = 0.42$, $p < .01$; $\sigma^2_{iCondition} = 0.35$, $p < .01$; $\sigma^2_{iStrength} = 0.29$, $p < .01$; $\sigma^2_{iSport} = 0.41$, $p < .01$; $\sigma^2_{iPhysical\ activity} = 0.15$, $p < .01$). There was also significant between-person heterogeneity in terms of change (slope variance) in all variables ($\sigma^2_{sGSE} = 0.05$, $p < .05$; $\sigma^2_{sPSW} = 0.05$, $p < .05$; $\sigma^2_{sBody} = 0.05$, $p < .05$; $\sigma^2_{sCond} = 0.04$, $p < .05$; $\sigma^2_{sStrength} = 0.03$, $p < .05$; $\sigma^2_{sSport} = 0.04$, $p < .05$); $\sigma^2_{i} = 0.03$, $p < .05$; $\sigma^2_{sPhysical\ activity} = 0.03$, $p < .05$).

There were significant intercept-slope correlations for all variables except for physical activity. All significant intercept-slope correlations were negative, indicating that a higher initial value was correlated with steeper decrease (or less increase depending on the direction of the mean of the slope) over time. For example, a higher PSW at baseline was associated with a steeper decrease in PSW over time.

Associations of Change Between Global Self-Worth, Physical Self-Perceptions and Physical Activity

The estimates from parallel growth latent curve models are described in Table 2 (model fit indices of all models are presented in Table 3 in the online supplemental material). The fit of the parallel LGCM was acceptable, with CFI values over .95 for all models, except for the GSE-Body model. The RSMEA estimates for several models (primary models including the GSE variable) are notably higher than the recommended cut-offs of .06 or .08. Nevertheless even small inaccuracies in the LGCM can lead to substantial lack of fit. Also, the RMSEA is positively biased and tends to be large in small models.

The intercepts (levels at baseline) of GSE were moderately to highly and positively correlated with the intercepts of all physical self-perception variables (*r*s = .43-.86, *p*s < .001). The slope of GSE was also positively and significantly correlated with the slopes of all physical self-perception variables (*r*s = .53-1.15, *p*s < .001), indicating support for moderate to strong correlated change between the higher order GSE and the more specific physical self-concepts. For some slope-slope associations (e.g., GSE-PSW, GSE-Body and PA- Cond, the standardized estimate was 1.0 or higher. For these correlations we also report the unstandardized estimates of association (covariance) in the Table 2.

These slope-slope correlations indicate associations on a between-person level. For example, if an individual decreased less (the average trend being a decrease in GSE, mirrored by a negative mean slope) in GSE compared to others, then he or she also demonstrated a more positive (i.e., less decrease or more increase depending on the average slope for the variable) change in the physical self-variables compared to others. Looking at associations on a within-person level, there were positive and significant (*r*s = .25-.45, *p*s < .01) associations between the time-specific residuals of GSE and all physical self-variables. This means that, for example, if an individual was higher on GSE at a certain measurement point than expected from his/her curve, then he or she also had higher scores than expected on physical self-perception variables. In other words, occasion-specific, or state-like, fluctuations (or deviations from the expected curve) in GSE were associated with similar fluctuations, in the same direction, in physical self-concepts.

Change in physical activity was not significantly associated with change in GSE, PSW or Body. Positive slope-slope correlations, however, were found between physical activity and the three physical self-perceptions variables Cond, Strength, and Sport (*r*s = .62-1.00, *p*s < .01), meaning that change in these physical self-perception domains was associated with change in physical activity on a between-person level. Also, at a within-person level, there were weak but significant correlations (*r*s = .12-.28, *p*s < .01) between residuals of physical activity, GSE and all physical self-perceptions subdomains (including the more general PSW) aside from Body. Occasions-specific fluctuations within-persons in physical activity were associated with similar within-person fluctuations in the same direction in GSE, PSW, Cond, Strength, and Sport.

The intercept-slope correlations across variables were negative in 15 out of 20 correlations, generally suggesting that a higher initial value in one variable was related to a steeper decrease in another. The only positive and significant intercept-slope correlations were found between intercepts of GSE and PSW and slope of PA (*r*s = .26 and .18, *p*s < .01 respectively), indicating that higher values at baseline in GSE and PSW were related to less decline in PA over time.

Discussion

The present study examined within-person changes in GSE, physical self-concepts and physical activity in adolescent girls. Whereas previous studies adopting a *launch-model* approach to development using cross-lagged analyses have concluded that the physical-self remains relatively stable across time (e.g., Crocker et al., 2006, Kowalski et al., 2003), the present study using a *change-to-change* model through LGCM demonstrated the dynamics of the self-system and average within-person change. It also showed a marked between-person variability in within-person change in most variables. The existence of within-person changes in self-perceptions and self-esteem is consistent with previous studies (e.g., Baldwin & Hoffman, 2002; Erol & Orth, 2011; Robins et al., 2002) that have used similar analytical approaches (e.g., LGCM) to measure self-esteem change in adolescence, indicating that adolescence is an important period in self-perception development and, therefore, might be a particular important time-period for interventions aimed at improving, in particular, PSP.

In general the results depict an average decline in PSP across grades 9-11. Thus, most self-perceptions became more negative across time, which supports previous work in terms of sport competence (e.g., Cole et al., 2001). GSE, however, did not demonstrate an average change and remain stable, which is in line with some previous works (e.g., Morin et al., 2011) but contradicted other studies, demonstrating significant average change in GSE across adolescence (e.g., Baldwin & Hoffman, 2002; Erol & Orth, 2011; Robins et al., 2002). An exception to the decline trend in PSP was found for body attractiveness that, instead, improved, an unexpected result that has also been found in previous work on girls in middle to late adolescence (Cole et al., 2001). This result may mirror a recovery from previous low levels of self-perception and self-esteem specifically linked to body attractiveness and physical appearance, a trend that frequently has been documented in late childhood and early to middle adolescent years for girls (e.g., Baldwin & Hoffman, 2002; Cole et al., 2001; Harter, 2012).

Aside from average trends in change for the different domains, the results also highlight substantial between-person heterogeneity, both in terms of starting level and change patterns. Even though the participants in the study were not involved in any major structural transition (e.g., from junior to senior high school) that may have set the stage for more substantial variations in self-perceptions change between persons (see Cole et al., 2001; Wigfield et al., 1991), between-person heterogeneity in change was still evident in all domains. Although we did highlight the importance of estimating heterogeneity in change patterns in the present study, we did not pursue the issue of heterogeneity further to explain, for example, why some girls decline in PSP and some do not. Future research in the area of change in GSW and PSP in girls across adolescence could move further in this direction and examine heterogeneity through the identification of latent classes and potential predictors of such classes (e.g., Muthen & Muthen, 2000).

As has been proposed by leading theorists in the field of self-concept, a number of age-related major developmental changes occur in adolescents perceptions of the self, such as: increasing proliferation of the subdomains, changes in the content of subdomains, and changes in cognitive-processes used to evaluate the self (Harter, 2012; Horn, 2004). Not only do cognitive systems within the person change, the sociocultural environment may also change, interacting with the aforementioned cognitive maturational changes to create observed trajectories in self-perception on an individual level. Together, these different types of forces may give rise to expected average trajectories of change in self-concept, but also offer a platform for understanding the observed between-person variability in change observed in the present study. Nevertheless, this also calls for sensitivity in future work to use analyses that, not only, properly address intra-individual change but also inter-individual differences in intra-individual change (Duncan et al., 2006; Schutz & Park, 2004).

Previous work has discussed whether more general/global self-concepts, such as GSE, should theoretically be more stable across time compared with specific self-concepts such as physical self-concepts (see Crocker et al., 2006; Kowalski et al., 2003; Marsh & Yeung, 1998). According to the bottom-up notion of the multidimensional and hierarchical model of Shavelson et al. (1976), GSE should be more stable, and thus, less likely demonstrate change, compared with self-perceptions and more specific levels, such as physical self-perceptions. This theoretical notion has, however, been questioned (Marsh & Yeung, 1998). Studies using part of the same data as the present study (Crocker et al., 2006; Kowalski et al., 2003), have also shown that the more specific physical self-concept is more stable than global self-esteem. With these results in hindsight, it is interesting to note that GSE in the results of the present study was the only self-concept variable that did not display a significant average change, which could be interpreted as GSE being more stable compared with the more specific physical self-concepts, contradicting the results of previous studies using the same data. It should also be noted, however, that average change in GSE was also marked by substantial and significant between-person variability (significant slope variance), further supporting the idea of the complexity in capturing and modeling the full dynamics of self-system change in adolescents. The use of LGCM offers the advantage of examining both average within-person change and between-person variability in change that traditional cross-lagged models used in previous works do not. Therefore, the results of the present study may contribute to a different perspective on the debate of self-concept change, but also provide a reminder that results and conclusions in studies are often closely intertwined with the analytical approach used and should not be interpreted or evaluated in isolation.

Change in physical self-perceptions was moderately to strongly associated with change in GSE on a between-person level, but also weakly to moderately associated on a within-person level (deviations from expected curve). Girls who reported more decrease in GSE, relative to the average, also reported more decrease in physical self-perceptions (and less increase in body attractiveness) relative to the average, and vice versa. Also, girls who demonstrated higher (than their own expected curve) than expected physical self-perceptions at a given occasion also showed higher than expected scores on GSE at that occasion. These results supports the notion that self-beliefs become increasingly integrated across adolescence and that change in one domain should accompany change in others (e.g., Cole et al., 2011, Harter, 2012), pointing out the dynamic interplay of the different parts of the self-system longitudinally (see also Morin et al., 2011). The strongest association between changes in GSE and physical self-perceptions was found for body attractiveness, supporting previous cross-sectional works that have found the physical self subdomain of body attractiveness to share the most variance with GSE (e.g., Fox, 1997; Lindwall et al., 2011).

The study targeted dynamic associations between parallel changes in different self-concepts. Therefore, no conclusions can be drawn in terms of predictions across time or direction of causal flow in the self-system (e.g., top-down versus bottom-up models), something that previous work has highlighted (e.g., Kowalski et al., 2003; Marsh & Yeung, 1998; Morin et al., 2011)[1].

The results of the present study demonstrate how within-person changes in general self-concepts (e.g., self-esteem), perceptions of the self on more specific levels (in this study physical self-perceptions), and physical activity are systematically interrelated and travel together across time. As suggested by previous work (Kowalski et al., 2003; Marsh & Yeung, 1998), the effect of reciprocal (horizontal) models rather than pure bottom-up or top-down models in the causal flow, most probably yield the best insight into the complex puzzle of systematic development in these concepts.

When elaborating on the differences in results between different types of studies, it is important to point out that cross-lagged models (often used in the launch models) and LGCM (used in the change-to-change model) ask and answer very different questions about change (e.g., Biesanz, 2012; Duncan et al., 2006; Little, 2013). The former models essentially deal with direction of influence of change, and focus solely on individual differences and between-persons standings in the variables across persons. LGCM, however, estimates within-person change where each individual receives his/her own intercept and slope. To our knowledge, this is the first study to examine change and associations of change in GSE, PSP and physical activity from a LGCM perspective, contributing to a complementary picture of the patterns of parallel developmental change in adolescents in these concepts.

The results of the present study, demonstrating within-person change as well as between-person differences in within-person change, might be perceived as being contradictory to previous work by Morin et al., (2011) that showed self-esteem and body image to be relatively stable across adolescence with negligible between-person variability in body-image change. Also, the present study depicted a different picture in relation to associations of change across time with evidence of associations of within-person change between GSE and PSP. In contrast, Morin and colleagues concluded that the associations between self-esteem and body image were quite small (going from body image to self-esteem but not the opposite). In the present study, however, we found within-person associations between residuals (deviations from expected curve) at each time-point in GSE and Body as well as other PSP subdomains. These associations may be compared with the substantial time-specific correlations at each occasion between self-esteem and body image found by Morin and colleagues. This finding points to the importance of modeling, not only associations between general trait-like components of change in different variables, but also associations between state-like “shocks” to the overall trajectories (Morin et al., 2011) or fluctuations across the general trajectory in, for example, GSE and body image. Elaborating on the different results found in the present study and the study by Morin and colleagues, it is important to note that the LGCM used in the present study and the ALT models primarily used in the Morin and colleagues study, are modeled and interpreted differently and consequently answer slightly different types of research questions when it comes to change and associations of change (e.g., Bollen & Curran, 2006; Morin et al., 2011). As the present study only contained data from three waves, testing an ALT model was not a suitable option.

Cross-sectional relations between GSE and physical activity were weak in the present study and we found no relationship between change in physical activity and GSE. These results are in line with previous reviews and meta-analyses (Crocker et al., 2008; Fox, 2000; Spencer et al., 2005). According to hierarchical models of the physical-self, linking specific behavior (physical activity) at the bottom, through more specific PSP in various domains in the middle, to general evaluations of the self (GSE) at the top (e.g., Fox, 1997; Sonstroem, 1998), physical activity is closer to, and should be more strongly associated with, more specific self-perceptions linked to the physical-self in comparison to general self-evaluations (GSE) that are situated further away from specific behavior (physical activity) in the model. Our results support this assumption and yield clear evidence for the idea that change in physical activity is related to change in PSP. These associations of change were not only found when using more traditional between-person types of analyses (i.e., changing more than average in physical activity is linked to changing more than average on physical self-concepts), but also when using within-person types of analyses. Although the associations between occasion-specific fluctuations (residuals) in physical activity and physical self-concept were weak in strength, they were significant for physical self-variables except for body attractiveness, indicating that systematic change did not only occur on a between-person level but also on a within-person level in a more state-like fashion. Hence, the conclusions drawn from previous reviews (mostly based on cross-sectional studies and associations) that the link between the behaviors and evaluations of the self should be stronger if the evaluations are measured on a more specific level (e.g., Marsh & Craven, 2006) is supported by our results conducted on relationships of within-person changes. This is also the conclusion of previous reviews that have particularly targeted the relationship between physical self-concepts and physical activity (e.g., Fox 2000; Spence et al., 2005).

The level-change (intercept-slope) correlations between variables were mainly negative. Interpreted from a conceptual viewpoint, these negative correlations indicate that persons with a higher baseline value in one variable (e.g., GSE) decreased more (as for *sport*), or increased less (as for *body*), in other variables. Negative level-change correlations are, however, common findings in research using closed-ended Likert type scales such as in the present study and may be more likely to be interpreted as artifacts of the scaling methods indicating regression to the mean or ceiling effects (Little, 2013). Given the overall patterns of intercept-intercept and slope-slope correlations across variables, the latter methodological artifact interpretation seems more viable in the present study. Only two positive and significant level-change correlations were found, between levels of GSE and PSW and change in PA. Conceptually these correlations make more sense (compared to the negative level-change correlations discussed above) and suggest that girls with higher GSE and PSW at baseline also decreased less in PA across the three years compared with girls lower on GSE and PSW at baseline. A higher GSE and general self-worth when it comes to the physical self may thus to some extent function as a buffer against the general trend of decrease in PA in late adolescence; a notion that seems in line with the self-enhancement theory (e.g., Calsyn & Kenny, 1977; Sonstroem, 1998).

Several limitations of the present study should also be highlighted. The previously discussed inability (given the parallel GLCM used) to examine directions of effects, or flow of effects, is a potential limitation of the study. As noted by other scholars (e.g., Morin et al., 2011), investigating not only parallel change, but also lagged effects and directions of effects, may give important insight into the complex dynamics of the self-system and behavior such as physical activity. For example, physical activity may affect self-perceptions (skill-development), or self-perceptions may influence physical activity (self-enhancement), or a reciprocal model (where flow goes in both directions) are all possible interpretations of the results (see additional analyses presented in the online supplemental material). Also, the use only of girls limits the generalizability of the results, especially given the evident gender differences in PSP (e.g., Cole et al., 2001; Lindwall & Hassmén, 2004) and GSE (Harter, 2012) that has been documented in previous work. For example, fluctuations in GSE across adolescence have been found to be substantially larger (and more negative with a marked decline) in girls compared to boys (Baldwin & Hoffmann, 2002). Also, in the present study, the LGCM were based on manifest variables rather than on latent variables, as is typically done in the majority of published papers using LGCM. Using latent variables, however, enables researchers to use second-order LGCM models (Sayer & Cumsille, 2001), and to control for measurement error and test for longitudinal invariance, something that we could not do in the present study. Consequently, we do not know how much measurement error influenced the estimates in our LGCM, and we had to assume (rather than being able to test) longitudinal invariance for the different variables, which should be viewed as an apparent weakness of the study.

References

Amorose, A. J. (2001). Intraindividual variability of self-evaluations in the physical domain: Prevalence, consequences, and antecedents. *Journal of Sport & Exercise Psychology, 23*(3), 222-244.

Aşçı, F. H. (2003). The effects of physical fitness training on trait anxiety and physical self-concept of female university students. *Psychology of Sport and Exercise, 4*, 255-264.doi: 10.1016/S1469-0292(02)00009-2

Baldwin & Hoffman (2002). The dynamics of self-esteem: A growth curve analysis. *Journal of Youth and Adolescence, 31* (2), 101-113. doi: 10.1023/A:1014065825598

Biesanz, J. C. (2012). Autoregressive longitudinal models. In R. H. Hoyle (Ed.), *Handbook of structural equation modeling* (pp. 459-471). New York: Guilford Press.

Bollen, K.A., & Curran, P.J. (2006). *Latent curve models: A structural equation perspective.* Hoboken, NJ: Wiley.

Çağlar, E., & Aşçı, F. H. (2006). Gender and physical activity level differences in physical self perception of university students: A case of Turkey. *International Journal of Sport Psychology, 37*, 58-74.

Calsyn, R. J., & Kenny, D. A. (1977). Self-Concept of Ability and Perceived Evaluation of Others - Cause or Effect of Academic-Achievement. *Journal of Educational Psychology, 69*(2), 136-145. doi:10.1037//0022-0663.69.2.136

Cole, D. A., Maxwell, S. E., Martin, J. M., Peeke, L. G., Seroczynski, A. D., Tram, J. M., . . . Maschman, T. (2001). The development of multiple domains of child and adolescent self-concept: A cohort sequential longitudinal design. *Child Development*, *72*(6), 1723-1746. doi: 10.1111/1467-8624.00375

Crocker, P. R., Eklund, R. C., & Kowalski, K. C. (2000). Children's physical activity and physical self-perceptions. *Journal of Sports Science, 18*(6), 383-394. doi: 10.1080/02640410050074313

Crocker, P.R.E., Kowalski, K., & Hadd, V. (2008). The role of self and identity in physical (in)activity. In A. Smith & S.J. Biddle (Ed.). *Youth Physical Activity and Inactivity: Challenges and Solutions* (pp.215-237). Champaign, IL: Human Kinetics

Crocker, P. R. E., Sabiston, C. M., Kowalski, K. C., McDonough, M. H., & Kowalski, N. (2006). Longitudinal assessment of the relationship between physical self concept and health related behavior and emotion in adolescent girls. *Journal of Applied Sport Psychology, 18*, 185-200. doi: 10.1080/10413200600830257

Duncan, T. E., Duncan, S. C., & Strycker, L. A. (2006). *An introduction to latent variable growth curve modeling: Concepts, issues, and applications (2nd ed.)*: Lawrence Erlbaum Associates Publishers, Mahwah, NJ.

Enders, C. K. (2010). *Applied missing data analysis*. New York: Guilford.

Erol, R. Y., & Orth, U. (2011). Self-esteem development from age 14 to 30 years: A longitudinal study. *Journal of Personality and Socical Psychology, 101*(3), 607-619. doi: 10.1037/a0024299

Fox, K. R. (1990). *The physical self-perception profile manual (PRN monograph).* Dekalb, IL: Northern Illinois University Office for Health Promotion.

Fox, K. R. (1997). The physical self and processes in self-esteem development. In K. R. Fox (Ed.), *The physical self from motivation to well-being* (pp. 111-140). Champaigne, IL: Human Kinetics.

Fox, K. R. (2000). Self-esteem, self-perceptions and exercise. *International Journal of Sport Psychology, 31*, 228-240.

Fox, K. R., & Corbin, C. B. (1989). The physical self-perception profile: development and preliminary validation. *Journal of Sport & Exercise Psychology, 11*(4), 408-430.

Fredricks, J. A., & Eccles, J. S. (2002). Children's competence and value beliefs from childhood through adolescence: Growth trajectories in two male-sex-typed domains. *Developmental Psychology, 38*(4), 519-533. doi:10.1037/0012-1649.38.4.519

Graham, J. W. (2009). Missing data analysis: Making it work in the real world. *Annual Review of Psychology, 60*, 549-576. doi: 58.110405.085530

Harter, S. (1988). *The Self-Perception Profile for Adolescents*. Unpublished manual, University of Denver, CO.

Harter, S. (2012). *The construction of the self : developmental and sociocultural foundations (2nd ed.)*. New York: Guilford Press.

Horn, T. S. (2004). Developmental perspectives on self-perceptions in children. In W. M. R (Ed.), *Developmental sport and exercise psychology: A lifespan perspective* (pp. 101-144). Morgantown: Fitness Information Technology.

Hu, L., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling, 6*(1), 1-55. doi:10.1080/10705519909540118

Kowalski, K. C., Crocker, P. R. E., & Kowalski, N. P. (1997). Convergent Validity of the Physical Activity Questionnaire for Adolescents. *Pediatric Exercise Science, 9*(4), 342.

Kowalski, K. C., Crocker, P. R. E., Kowalski, N. P., Chad, K. E., & Humbert, M. L. (2003). Examining the physical self in adolescent girls over time: Further evidence against the hierarchical model. *Journal of Sport & Exercise Psychology, 25*, 5-18.

Lindwall, M., Asci, F. H., Palmeira, A., Fox, K. R., & Hagger, M. S. (2011). The importance of importance in the physical self: support for the theoretically appealing but empirically elusive model of James. *Journal of Personality, 79*(2), 303-334. doi: 10.1111/j.1467-6494.2010.00678.x

Lindwall, M., & Hassmen, P. (2004). The role of exercise and gender for physical self-perceptions and importance ratings in Swedish university students. *Scandinavian Journal of Medicine and Science in Sports, 14*(6), 373-380. doi: 10.1046/j.1600-0838.2003.372.x

Lindwall, M., & Lindgren, E.-C. (2005). The effects of a 6 month exercise intervention programme on physical self-perceptions and social physique anxiety in non-physically active adolescent Swedish girls. *Psychology of Sport and Exercise*, *6*, 643-658. doi: 10.1016/j.psychsport.2005.03.003

Little, T. D. (2013). *Longitudinal structural equation modeling*. New York: Guilford Press.

Marsh, H. W., & Craven, R. G. (2006). Reciprocal effects of self-concept and performance from a multidimensional perspective: Beyond seductive pleasure and unidimensional perspectives. *Perspectives on Psychological Science*, *1*(2), 133-163. doi: 10.1037/h0050099

Marsh, H. W., & Yeung, A. S. (1998). Top-down, bottom-up, and horizontal models: The direction of causality in multidimensional, hierarchical self-concept models. *Journal of Personality and Social Psychology, 75*(2), 509-527.doi: 10.1037/0022-3514.75.2.509

Meredith, W., & Tisak, J. (1990). Latent curve analysis. *Psychometrika, 55*(1), 107-122. doi: 10.1007/BF02294746

Morin, A. J. S., Maïano, C., Marsh, H. W., Janosz, M., & Nagengast, B. (2011). The Longitudinal Interplay of Adolescents' Self-Esteem and Body Image: A Conditional

Autoregressive Latent Trajectory Analysis. *Multivariate Behavioral Research, 46*, 157-201. doi:10.1080/00273171.2010.546731

Muthén, B. & Muthén, L. (2000). Integrating person-centered and variable-centered analysis: growth mixture modeling with latent trajectory classes. *Alcoholism: Clinical and Experimental Research*, 24, 882-891. doi: 10.1111/j.1530-0277.2000.tb02070.x

Orth, U., Robins, R. W., & Widaman, K. F. (2012). Life-span development of self-esteem and its effects on important life outcomes. *Journal of Personality and Social Psychology, 102*(6), 1271-1288. doi: 10.1037/a0025558

Robins, R. W., Trzesniewski, K. H., Tracy, J. L., Gosling, S. D., & Potter, J. (2002). Global self-esteem across the life span. *Psychology and Aging, 17*(3), 423-434. doi: 10.1037/0882-7974.17.3.423

Sayer, A. G., & Cumsille, P.E. (2001). Second-order latent growth models. In L.M. Collins & A.G. Sayer, (Eds.), *New methods for the analysis of change* (p. 179-200). Washington, D. C.: American Psychological Association.

Schutz, R. W., & Park, I. (2004). Some Methodological Considerations in Developmental Sport and Exercise Psychology. In M. R. Weiss (Ed.), *Developmental sport and exercise psychology: A lifespan perspective.* (pp. 73-99): Fitness Information Technology, Morgantown, WV.

Shavelson, R. J., Hubner, J. J., & Stanton, G. C. (1976). Self-concept: Validation of construct interpretations. *Review of Educational Research, 46*(3), 407-441.doi: http://dx.doi.org/10.2307/1170010

Skinner, E. A., Zimmer-Gembeck, M. J., & Connell, J. P. (1998). Individual differences and the development of perceived control - Introduction and overview. *Monographs of the Society for Research in Child Development, 63*(2-3). doi:10.2307/1166220

Slutzky, C. B., & Simpkins, S. D. (2009). The link between sports participation and self-esteem: Exploring the mediating role of sport self-concept. *Psychology of Sport and Exercise*, *10*, 381-389. doi:10.1016/j.psychsport.2008.09.006

Sonstroem, R. J. (1998). Physical self-concept: assessment and external validity. *Exercise and Sport Sciences Reviews, 28*, 133-164.

Spence, J., McGannon, K., & Poon, P. (2005). The effect of exercise on global self-esteem: A quantitative review. *Journal of Sport & Exercise Psychology, 27,* 311-334.

Wigfield, A., Eccles, J. S., Mac Iver, D., Reuman, D. A., & Midgley, C. (1991). Transitions during early adolescence: Changes in children's domain-specific self-perceptions and general self-esteem across the transition to junior high school. *Developmental Psychology*, *27*(4), 552-565. doi:10.1037/0012-1649.27.4.552

Willett, J. B., & Sayer, A. G. (1994). Using covariance structure analysis to detect correlates and predictors of individual change over time. *Psychological Bulletin*, *116*(2), 363-381.doi: 10.1037/0033-2909.116.2.363

Footnotes

[1] To complement our analyses, we also conducted bivariate cross-lagged models on all combinations of the variables to get some insight into the direction of effects between GSE and lower order physical self-perceptions on one hand, and between PA and PSP on the other hand. These results are described in the online supplemental material.

Table 1.

Parameter Estimates (and Standard Errors, SE) from Univariate Latent Growth Curve Models

	Means Estimates		Variance Estimates		R-square[1]	IS-corr
	I (SE)	S (SE)	I (SE)	S (SE)		
GSE[a]	2.92 (.03)**	.01 (.01)	.36 (.03)**	.05 (.01)**	.68/.61/.77	-.47**
PSW[b]	2.64 (.03)**	-.04 (.01)**	.39 (.03)**	.05 (.01)**	.79/.71/.85	-.42**
Body[c]	2.31 (.02)**	.04 (.01)**	.42 (.03)**	.05 (.01)**	.86/.68/.86	-.39**
Cond[d]	2.76 (.03)**	-.09 (.01)**	.35 (.03)**	.04 (.01)**	.82/.70/.86	-.32**
Strength[e]	2.57 (.02)**	-.03 (.01)*	.29 (.02)**	.03 (.01)**	.80/.70/.85	-.23**
Sport[f]	2.62 (.03)**	-.06 (.01)**	.41 (.03)**	.04 (.01)**	.85/.79/.95	-.26**
PA[g]	2.63 (.02)**	-.22 (.01)*	.15 (.02)**	.03 (.01)**	.60/.63/.69	-.00

Note: I: Intercept; S:slope; GSE: Global self-esteem; PSW: Physical self-worth; Body: Body attractiveness; Cond: Physical condition; Strength: Physical Strength; Sport: Sport competence; PA: Physical activity; IS-corr: Intercept-slope correlation. [1] R-square is the proportion of variance in the three time repeated measures (e.g., GSE at T1, T2 and T3) that are explained by the model. Fit Indices of the models are described in Table 3 in the online supplemental material.

Table 2.

Correlations Between Intercepts, Slopes and Residuals of Physical Activity, Global Self-Esteem and Physical Self-Perceptions

	GSE			PA		
	I	S	Res	I	S	Res
PSW						
I	.86*	-.43*		.44*	.18*	
S	-.49*	1.05*[1]		-.10	.18	
Res			.35*/.34*/.43*			.12*/.17*/.15*
Body						
I	.75*	-.33*		.17*	.04	
S	-.54*	1.15*[2]		.04	.17	
Res			.37*/.39*/.40*			.06/.06.06
Cond						
I	.66*	-.33*		.74*	.04	
S	-.32*	.73*		-.35*	1.00*[3]	
Res			.31*/.28*/.45*			.22*/.28*/.24*
Strength						
I	.43*	-.27*		.50*	.02	
S	-.18*	.59*		-.13	.66*	
Res			.28*/.19*/.39*			.15*/.17*/.18*
Sport						
I	.52*	-.27*		.64*	.03	
S	-.16*	.53		-.09	.62*	
Res			.25*/.24*/.43*			.13*/.17*/.20*
PA						
I	.21*	-.12				
S	.26*	.01				
Res			.08*/.12*/.11*			

Note: I: Intercept; S: slope ; Res: Residuals (correlations between residuals at each of the three time-points); GSE: Global self-esteem; PSW: Physical self-worth; Body: Body attractiveness; Cond: Physical condition; Strength: Physical Strength; Sport: Sport competence; PA: Physical activity; [1] unstandardized estimate (covariance): 0.042 (0.005), p<.001; [2]unstandardized estimate (covariance): 0.034 (0.004), p<.001; [3] unstandardized estimate (covariance): 0.021 (0.004), *p<.01; Fit Indices of the models are described in Table 3 in the online supplemental material.

Online supplemental material

Descriptive statistics and correlation matrix of study variables

Descriptive statistics and the correlation matrix of the study variables are presented in Tables 1 and 2. Fit indices of the univariate and parallel latent growth curve models are described in Table 3.

Table 1

Descriptive Statistics for the Variables in the Study

Variables	T1		T2		T3	
	M	SD	M	SD	M	SD
GSE	2.91	0.72	2.94	0.67	2.95	0.62
PSW	2.64	0.70	2.57	0.67	2.58	0.64
Body	2.31	0.69	2.32	0.71	2.39	0.66
Cond	2.75	0.65	2.67	0.67	2.60	0.64
Strength	2.57	0.60	2.53	0.62	2.53	0.61
Sport	2.62	0.69	2.54	0.70	2.51	0.67
PA	2.65	0.61	2.39	0.55	2.22	0.68

Note: GSE: Global self-esteem; PSW: Physical self-worth; Body: Body attractiveness; Cond: Physical condition; Strength: Physical Strength; Sport: Sport competence; PA: Physical activity; T1= time point 1 (baseline); T2= time point 2 (baseline + 1 year); T3= time point 3 (baseline + 2 years).

Table 2

Correlation Matrix for the Variables in the Study

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1.GSET1	1																				
2.GSET2	.60	1																			
3.GSET3	.50	.62	1																		
4.PSWT1	.63	.52	.47	1																	
5.PSWT2	.49	.65	.52	.71	1																
6.PSWT3	.43	.54	.62	.62	.72	1															
7.BodT1	.54	.43	.42	.67	.55	.52	1														
8. BodT2	.44	.61	.49	.57	.73	.59	.72	1													
9. BodT3	.35	.44	.51	.51	.58	.75	.65	.72	1												
10.ConT1	.48	.37	.33	.76	.66	.59	.54	.47	.45	1											
11.ConT2	.40	.49	.37	.59	.80	.62	.42	.55	.44	.71	1										
12.ConT3	.33	.38	.45	.55	.65	.77	.37	.42	.54	.65	.73	1									
13.StrT1	.34	.21	.19	.54	.43	.38	.25	.18	.14	.55	.43	.39	1								
14.StrT2	.22	.29	.20	.38	.54	.42	.14	.24	.17	.40	.52	.43	.70	1							
15.StrT3	.21	.25	.32	.39	.47	.57	.18	.21	.28	.44	.48	.59	.66	.73	1						
16.SpoT1	.39	.30	.25	.65	.57	.48	.37	.31	.25	.73	.60	.53	.59	.46	.48	1					
17.SpoT2	.33	.41	.30	.56	.70	.56	.33	.41	.32	.63	.75	.61	.50	.58	.54	.78	1				
18.SpoT3	.30	.35	.36	.54	.61	.68	.30	.32	.39	.64	.67	.75	.49	.52	.62	.74	.83	1			
19.PAT1	.13	.11	.11	.29	.30	.28	.11	.11	.13	.50	.43	.41	.34	.26	.30	.45	.44	.45	1		
20.PAT2	.18	.19	.09	.32	.40	.30	.15	.18	.17	.46	.58	.48	.31	.35	.33	.45	.52	.48	.55	1	
21.PAT3	.19	.19	.20	.32	.35	.37	.14	.14	.18	.45	.50	.55	.30	.30	.37	.40	.46	.51	.56	.63	1

Note: GSE T1-T3 = Global self-esteem T1-T3; PSW T1-T3 = Physical self-worth T1-T3; Bod T1-T3= Body attractiveness T1-T3; Con T1-T3 = Physical condition T1-T3; Str T1-T3 = Physical strength T1-T3; Spo T1-T3 = Sport competence T1-T3; PA T1-T3 = Physical activity T1-T3

Table 3

Fit Indices for the Univariate and Parallel Latent Growth Curve Models (LCGM)

Model	χ^2	CFI	TLI	RMSEA	90% CI RMSEA
Univariate LGCM[1]					
GSE	0.88 ns	1.00	1.00	.000	.000-.097
PSW	3.92*	1.00	0.99	.064	.001-.137
Body	2.97 ns	1.00	0.99	.053	.000-.127
Cond	0.46 ns	1.00	1.00	.000	.000-.060
Strength	1.21 ns	1.00	1.00	.018	.000-.104
Sport	0.98 ns	1.00	1.00	.000	.000-.099
PA	1.12 ns	1.00	1.00	.016	.000-.121
Parallel LGCM [2]					
GSE-PSW	94.51**	0.96	0.91	.133	.110-.158
GSE-Body	124.43**	0.94	0.87	.154	.131-.179
GSE-Cond	63.43**	0.97	0.93	.107	.084-.132
GSE-Strength	35.12**	0.98	0.96	.076	.052-.101
GSE-Sport	49.51**	0.98	0.96	.093	.070-.118
GSE-PA	17.50**	0.99	0.98	.046	.019-.074
PA-PSW	25.98**	0.99	0.98	.062	.038-.088
PA-Body	38.47**	0.98	0.98	.060	.040-.081
PA-Cond	74.88**	0.97	0.95	.091	.072-.111
PA-Strength	47.85**	0.98	0.97	.069	.050-.090
PA-Sport	57.95**	0.98	0.97	0.78	.059-.098

Note: [1] Univariate GLCM have 1 df; [2] Parallel GLCM have 7 df; ns = non significant;*p=.05; **p<.001; GSE: Global self-esteem; PSW: Physical self-worth; Body: Body attractiveness; Cond: Physical condition; Strength: Physical Strength; Sport: Sport competence; PA: Physical activity; CFI = Bentler's comparative fit index; TLI = the Tucker-Lewis Index; RMSE = Root mean square error of approximation.

Cross-lagged analyses

To complement our analyses, we also conducted bivariate cross-lagged models on all combinations of the variables to get some insight into the direction of effects between GSE and lower order physical self-perceptions on one hand, and between PA and PSP on the other hand. The cross-lagged models used were based on manifest variables (total scores) and included autoregressive paths, thereby estimating the effect of one variable (e.g., GSE) on subsequent level of another variable (e.g., PA) while controlling for the effect of the first variable at the first occasion on itself on the second occasion.

We first tested the predictive equilibrium of the model (see Cole & Maxwell, 2003), that is, if paths were equal across time points (e.g., the GSET1 → BodyT2 path did not differ from the GSET2 → BodyT3 path). We used an analytical approach where we constrained respective paths to be equal across time points and compared the fit of this model to a model where the paths were freely estimated. The Wald chi-square test in Mplus was used to test if the constrained paths resulted in a significant decrease in model fit, which would indicate that the paths were not invariant across time points. Also, changes in CFI and TLI below .01, and changes in RMSEA remaining under .015 (see Cheung and Rensvold, 2002; Chen, 2007 were used as additional criteria to interpret if the constrained model fitted data worse than the unconstrained model. All paths were found to be invariant (equal) across time points, yielding support for the predictive equilibrium of the models. Therefore the results presented in Tables

4 and 5 are from the models with predictive equilibrium. As the paths between T1-T2 and T2-T3 in these models are set to be equal, the unstandardized estimates for the T1-T2 and T2-T3 paths are the same within each pair of variables.

Table 4

Cross-lagged Estimates in the Cross-lagged Models Including Global-Self-Esteem and Physical Self-Perceptions

	Parameter estimate		Critical ratio
	US (SE)	S	
Top-down direction[1]			
GSET1 → BodyT2	0.03 (0.03)	.03	1.32
GSET2 → BodyT3	0.03 (0.03)	.03	1.32
GSET1 → SportT2	0.03 (0.02)	.03	1.52
GSET2 → SportT3	0.03 (0.02)	.03	1.52
GSET1 → CondT2	0.05 (0.02)	.07	2.09*
GSET2 → CondT3	0.05 (0.02)	.02	2.09*
GSET1 → StrengthT2	0.02 (0.02)	.02	1.05
GSET2 → StrengthT3	0.02 (0.02)	.02	1.05
Bottom-up direction[2]			
BodyT1 → GSET2	0.15 (0.04)	.16	5.83*
BodyT2 → GSET3	0.15 (0.04)	.17	5.83*
SportT1 → GSET2	0.07 (0.02)	.07	3.07*
SportT2 → GSET3	0.07 (0.02)	.08	3.07*
CondT1 → GSET2	0.09 (0.03)	.09	3.70*
CondT2 → GSET3	0.09 (0.03)	.10	3.70*
StrengthT1 → GSET2	0.04 (0.02)	.03	1.38
StrengthT2 → GSET3	0.04 (0.03)	.04	1.38

[1] paths going from the higher order GSE to the lower order physical self-perceptions;[2] paths going from lower order physical self-perceptions to the higher order GSE; GSE: Global self-esteem; PSW: Physical self-worth; Body: Body attractiveness; Cond: Physical condition; Strength: Physical Strength; Sport: Sport competence; PA: Physical activity; *<.05

The results (see Table 4) generally support the notion that paths are more evident from lower order self-perceptions to GSE than the opposite direction, supporting a bottom-up hypothesis more than a top-down hypothesis (see Marsh, 1990; Morin et al., 2011). In terms of paths from PA and lower order physical self-perceptions (see Table 5), the results show significant cross-lagged estimates from both directions, thereby supporting reciprocal relationships across time. In terms of PA and GSA, however, the paths from GSA to subsequent PA were significant whereas the opposite paths were not, indicating stronger support for a self-enhancement perspective rather than a skill-development perspective when it comes to the PA and GSA longitudinal association.

Table 5

Cross-lagged Estimates in the Cross-lagged Models Including Physical Activity, Global Self-Esteem and Physical Self-Perceptions

	Parameter estimate		Critical ratio
	US (SE)	S	
Skill-development[1]			
PAT1 → GSET2	0.01 (0.03)	.01	0.39
PAT2 → GSET3	0.01 (0.03)	.01	0.39
PAT1 → BodyT2	0.05 (0.02)	.04	1.98*
PAT2 → BodyT3	0.05 (0.02)	.04	1.98*
PAT1 → SportT2	0.11 (0.02)	.10	4.76*
PAT2 → SportT3	0.11 (0.02)	.09	4.76*
PAT1 → CondT2	0.11 (0.03)	.10	3.97*
PAT2 → CondT3	0.11 (0.03)	.09	3.97*
PAT1 → StrengthT2	0.07 (0.02)	.04	2.85*
PAT2 → StrengthT3	0.07 (0.02)	.08	2.85*
Self-enhancement[2]			
GSET1 → PAT2	0.09 (0.02)	.12	4.39*
GSET2 → PAT3	0.09 (0.02)	.09	4.39*
BodyT1 → PAT2	0.06 (0.02)	.08	3.07*
BodyT2 → PAT3	0.06 (0.02)	.07	3.07*
SportT1 → PAT2	0.18 (0.02)	.23	8.18*
SportT2 → PAT3	0.18 (0.02)	.19	8.18*
CondT1 → PAT2	0.21 (0.03)	.24	8.34*
CondT2 → PAT3	0.21 (0.02)	.20	8.34*
StrengthT1 →PAT2	0.12 (0.02)	.13	5.02*
StrengthT2 → PAT3	0.12 (0.02)	.11	5.02*

US= Unstandardized estimates; S= standardized estimates; [1]paths going from physical activity GSE and physical self-perceptions;; [2] paths going GSE and physical self-perceptions to physical activity; GSE: Global self-esteem; PSW: Physical self-worth; Body: Body attractiveness; Cond: Physical condition; Strength: Physical Strength; Sport: Sport competence; PA: Physical activity; *<.05