Attachment relationships and physical activity in adolescents: The mediation role of physical self-concept

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Running head: Attachment, self-concept and physical activity

ABSTRACT

Objectives: Based on the integration of attachment and physical self-perception perspectives, the present study examined links between adolescents’ engagement in physical activity and their attachment relationships with mothers, fathers, and friends, respectively, and assessed the potential mediation role of physical self-perception in this link.

Design and Methods: Using a cross-sectional design, questionnaire data was obtained from 767 adolescents (49% boys, \( M_{age} = 12.92, \) SD = .86) and structural equation modeling was used to examine relationships among variables.

Results: Attachment security with parents and friend was associated with higher levels of physical activity. There was partial support of the mediation role of physical self-perception, as adolescents who were securely attached to mother and friend perceived themselves as having better physical condition, which in turn predicted greater engagement in physical activity. The mediation role of physical self-perception between mother attachment and PA was stronger for female adolescents. Secure attachment to father had a direct positive effect on physical activity. The direct effect was strongest for male adolescents.

Conclusions: Our findings highlight the importance of relationship-based intervention strategies to enhance and maintain healthy regular physical activity among adolescents.

Keywords: Attachment security; Parents; Peers; Self-perception; Health behavior
While physical and psychological benefits of regular physical activity (PA) in youth are undeniable, both cross-sectional (e.g., Allison, Adlaf, Dwyer, Lysy, & Irving, 2007) and longitudinal (e.g., Kimm et al., 2000) studies consistently show that participation in PA declines dramatically during early adolescence (Malina & Katzmarzyk, 2006). Early adolescence is characterized by substantial biological growth and pubertal maturation (Malina, Bouchard, & Bar-Or, 2004) which may impact health related behaviors. Relations with parents and peers also transform during transition to adolescence (Greenberg, Siegel, & Leitch, 1983; Allen, 2003) and aspects of these relationships may influence the engagement in unhealthy or healthy behaviors. Indeed, parents affect their children’s attitude toward PA (e.g., Trost et al., 2003) and there is some evidence that fathers’ support may be more explicit and directly related to the child’s PA levels, compared to mothers’ (Beets, Cardinal, & Alderman, 2010). At the same time, several studies underscore the impact of friends on young individuals’ PA (e.g., Smith, 1999, 2003; Ullrich-French & Smith, 2006). Clearly, social relationships have important implications for PA motivation and behavior (e.g., Edmunds, Ntoumanis, & Duda, 2006) but to date, little is known about the distinct contribution of different specific relationships for adolescents’ PA behavior.

A commonly discussed pathway accounting for the link between social relationships and PA motivation and behavior may be summarized under the term “social support” and several descriptive studies have provided evidence that perceived social support is correlated with PA in children and adolescents (Allender, Cowburn, & Foster, 2006; Sallis, Prochaska, & Taylor, 2000; Van Der Horst, Paw, Twisk, & Van Mechelen, 2007; Beets et al., 2010). However, although social support has been considered in PA intervention programs (Harris, Oelbaum, & Flomo, 2007; Prochaska & Marcus, 1994), longitudinal and intervention studies have only found marginal
evidence for a causal relationship between social support and PA (Lubans, Foster, & Biddle, 2008; O’Conner, Jago, & Baranowski, 2009). These results suggest that social support may be important for explaining PA motivation and behavior in children and adolescents, but that in order to better understand the observed decline in PA among adolescents, and reach beyond enacted and perceived social support, empirical models of PA that conceptualize different personal relationships simultaneously may be necessary. The present study proposes and tests such a model.

Few studies within the field of sport and exercise psychology have focused on understanding engagement in health behaviors based on relationship theories. Attachment theory, a conceptual and empirical framework concerning the formation and importance of early emotional bonds between children and their caregivers, has shown promise in explaining how relationships with salient others may foster, or undermine, PA motivation and engagement (Ullrich-French, Smith, & Cox, 2011), physical health (Pietromonaco & Uchino, 2013), health behaviors (Huntsinger & Luecken, 2004) and athletes’ psychological well-being (Felton & Jowett, 2013). Attachment theory regards the caregiver as “a secure base”, fostering, promoting and supporting the child’s exploration, and as “a safe haven”, protecting and soothing the child in times of difficulty (Ainsworth, Blehar, Waters, & Wall, 1978; Bowlby 1969/1982, 1973, 1988). Experiences with a reliable, sensitive and responsive caregiver promote knowledge, on the child’s side, that the caregiver will be available and responsive when and as needed, resulting in a secure attachment (Ainsworth et al., 1978). Reinforced by sensitive and empathic parental responses that do not selectively dismiss certain feelings or experiences, the child is trustful and eager to communicate both positive and negative emotions. In contrast, experiences with caregivers who ignore or dismiss the child’s needs of security and protection are likely to result in the child learning to minimize the
importance of caregiver availability, suppress the communication of both negative and positive emotions, and avoid relational closeness (Cassidy, 1994), what is termed avoidant insecure attachment (Ainsworth et al., 1978), while experiences with caregivers who respond minimally or inconsistently to the child’s needs are likely to lead to lack of trust and anxiety concerning the availability of caring attention, and compensatory strategies of displaying elevated negative emotionality for securing the needed attention, what is termed resistant or fearful insecure attachment (Ainsworth et al., 1978; Cassidy, 1994).

Through continuous and repeated affective exchanges and experiences, and as cognitive, linguistic and social skills mature, early experiences of parent-child interactions become internalized into mental representations (internal working models, IWMs: Bowlby, 1973; Bretherton, 1991). Mental representations of attachment security allow the child to mentally “bring close” the caregiver, whose physical proximity cannot be guaranteed at all times, thereby moderating distress from separation and facilitating exploration in the caregiver’s absence (Bowlby 1969/1982, 1973, 1988). Since they encompass unconscious rules for behavior and emotion regulation in close relationships, IWMs of attachment are thought to also give rise to relatively stable individual attachment styles influencing close relations later on in life. During adolescence, the secure attachment style is characterized by high levels of trust and relatedness towards both parents and friends. The avoidant insecure attachment style is characterized by little trust of others, and an avoidance of closeness. The resistant insecure attachment style is characterized by eagerness for intimate relationships, yet lack in trust that the individual is being understood by others and high anxiety that these others will not accept them, or abandon them.

As mental representations of early relationships, attachment representations are thought to
also include self-perceptions of one’s value and worthiness of care, giving rise to expectations that influence beliefs and feelings about the self. Different attachment styles involve different mental models of self. For example, when the caregiver does not answer, denies or responds inconsistently to the child’s needs, the child is likely to develop a mental schema in which he/she is not worthy of sensitive care and love (Bartholomew, 1990; Bretherton, 1985). Indeed, Harter (1999) suggested that “the personal self develops in the crucible of interpersonal relationships with significant others” (p. 166) and Hinde and colleagues (2001) demonstrated that individual self-perceptions and perceptions of interpersonal relationships are closely linked to one another. Consistently, research has shown positive associations between secure attachment to parents and positive self-perceptions (Cassidy, Ziv, Metha, & Feeney, 2003; Doyle, Markiewicz, Brendgen, Lieberman, & Voss, 2000; Psouni, Di Folco & Zavattini, 2015; Verschueren & Marcoen, 2002, 2005). Relation-specific influences have also been shown: for example, attachment security in relation to father predicts self-perceptions of high academic competence (Bacro, 2012), while attachment security in relation to peers predicts a positive social self-perception (Verschueren, Doumen, & Buyse, 2012).

One component of self-perception is physical self-perception, defined as the individual’s perception of self in terms of body strength, attractiveness and other aspects related to the physical domain, which, according to a hierarchical model of physical self-perception can be summarized in four specific subdomains: sport competence, physical conditioning (fitness), body attractiveness, and physical strength (Fox & Corbin, 1989). Recent studies have highlighted the importance of physical self-perception for health-related behaviors in populations of different ages (e.g., Crocker, Eklund, Kowalski, 2000; Crocker, Sabiston, Kowalski, McDonough, & Kowalski, 2006) and in
young people in specific (e.g., Sabiston & Crocker, 2008). Findings from a systematic review and meta-analysis summarizing cross-sectional, longitudinal and experimental studies, suggest a significant association between children’s and adolescents’ physical self-perception and PA (Babic et al., 2014), particularly to the subdomains of perceived competence and fitness. While causality could not be established, leaving unclear whether self-perception and its subdomains ought to be regarded as outcomes, mediators or moderators in adolescents’ PA, the meta-analysis clearly showed that age moderated the link between perceived competence, perceived appearance (body attractiveness), and PA as this relationship was stronger for adolescents compared to children. Additionally, sex was found to be a significant moderator in the link between general physical self-perception and PA, with a stronger relation found in boys (Babic et al., 2014). In this context, exploring the potential antecedents of, and pathways for, enhanced physical self-perception in children and adolescents, is of paramount importance.

Potential influences of social relationships (to parents, peers and friends) on physical self-perceptions have been investigated. For instance, Smith (1999) found that adolescents’ perceptions of peer acceptance positively predicted physical self-worth and highlighted the importance of peer relationships in the development of physical self-perceptions (Smith, 2003). Young athletes’ descriptions of physical self in terms of skill development, body shape, physiological competence, mental competence and overall performance were predicted by perceived quality of relationship with coaches and parents (Jowett & Cramer, 2010). Positive associations have also been shown between adolescents’ attachment security to parents and perceptions of global self-worth, social acceptance, and specific perceptions of athletic competence and physical appearance (Papini & Roggman, 1992), highlighting the usefulness of
the attachment framework for a better understanding of PA motivation and behavior.

So do self-perceptions mediate the link between attachment security and PA motivation and behavior? Indeed, evidence from other domains of behavior supports this notion. For example, Gomez and McLaren (2007) showed longitudinally that attachment to father and mother had distinct impacts on aggression via the mediation of self-esteem. Self-perception (non-academic self, academic-self, and self-esteem) longitudinally mediated the relationship between peer attachment security and mental health problems among Japanese adolescents (Nishikawa, Sundbom, & Hägglöf, 2010). Huntsinger and Luecken (2004) found that young adults reporting secure attachments had higher self-esteem, which in turn was associated with healthy behaviors (exercise participation, low alcohol consumption, and nutrition). Turning to the field of PA, Ullrich-French and colleagues (2011) demonstrated that college students’ attachment security regarding parents and friends was associated with higher intrinsic motivation for, and actual levels of, PA. In line with Self-Determination Theory (Deci & Ryan, 1985), psychological needs (perceived competence, autonomy and relatedness) mediated the association between attachment security to father and PA motivation. In line with these findings and extrapolating from Harter’s (1999) suggestion that self-perceptions in a specific domain may influence the initiation and maintenance of behaviors in that domain, we suggest that physical self-concept, as the sub-component of self-perception most closely related to the PA domain, could be specifically mediating the link between attachment security and initiation and maintenance of PA.

To sum up, the present study explored the relationship between attachment security and PA behavior in adolescence and the potential role of positive physical self-perception in mediating this relationship. Since early adolescence is a critical transition phase during which relationships
with both parents and friends may have a crucial impact on the adolescent’s engagement in PA, distinct links between PA behavior and attachment security in relation to mother, father, and friend, respectively, were explored, assessing the potential mediating role of physical self-perception for each of these relationships. Employing a multidimensional and hierarchical model of physical self-perception (Fox & Corbin, 1989), the study explored how attachment security in relation to mother, father and friends, respectively, might be linked to the different subdomains of physical self-perception and assessed the strength in the links between these different subdomains and PA behavior in adolescence. It was expected that (i) mother, father and friend attachment security would positively predict physical self-perceptions; (ii) physical self-perceptions would, in turn, positively predict PA behavior; (iii) attachment security in these relationships would indirectly predict PA, through physical self-perceptions. As some previous research in relation to gender differences concerning the link between attachment security and self-perception in relation to PA (e.g., Song, Thompson & Ferrer, 2009; Wilkinson, 2004), the secondary purpose was to examine whether gender could possibly moderate the relations among these study variables.

METHOD

Participants

Participants were 783 Chinese adolescents (49% male) between 11 and 15 years’ old (M = 12.92 years, SD = .86), enrolled from four public schools from the east and south area of China. Public schools were chosen in order to collect a sample representative of adolescent students in this region. The selected schools were similar in terms of enrollment size, schedule of physical education (PE) classes, location (urban or suburban area) and socio-economic status of the families in the areas they served, in order to minimize the impact of external confounding factors.
Participants regularly attended PE classes 2-3 times per week (40 minutes per class). None were competing in sport at National or International level.

**Measures**

Attachment relationships with parents and friends were measured with the *Inventory of Parent and Peer Attachment* (IPPA; Armsden & Greenberg, 1987), which contains 25 items, repeated for each attachment relationship (mother, father, and peer). Participants were instructed to answer questions of the peer attachment subscale based on the relationship with their best friend. Each relationship is assessed on three dimensions: trust (attachment figures understand and support one’s needs and desires; e.g. “*My mother respects my feelings*”), communication (attachment figures are sensitive and responsive to one’s emotional states; e.g. “I like to get my father’s view on things I’m worried about”), and alienation (avoidance of intimacy from attachment figures; e.g. “I feel silly or ashamed when I talk about my problems with my best friend*”). Responses are on a 5-point scale from “almost never or never true” to “almost always or always true”. As the three dimensions are likely to be inter-correlated and in line with Armsden and Greenberg’s (1987) recommendation, alienation sub-scores were subtracted from the sum of trust and communication sub-scores to obtain a global attachment security score.

The Chinese version of the IPPA that was used here is validated (IPPA-R; Zhang, Zhang, Zhang, Wang, & Huang, 2011). In the present study, confirmatory factor analyses (CFA) were conducted containing 3 first-order latent variables (trust, communication, and alienation) for each attachment relationship. The fit indices (after deleting 4 problematic items\(^1\)) were as follows:

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\(^1\) *Note.* The mother communication item ‘*My mother has her own problems, so I don’t bother her with mine*’, the father trust item ‘*My father expects too much from me*’, and father communication item ‘*My father has his own problems, so I don’t bother him with mine*’, and peer alienation item ‘*I feel the need to be in touch with my friends more often*’ were removed.
Mother attachment ($\chi^2(246) = 704.30, p < .001, \text{CFI} = .92, \text{TLI} = .91, \text{RMSEA} = .05, \text{SRMR} = .05$; one item on the communication subscale deleted due to negative loading); Father attachment ($\chi^2(224) = 811.16, p < .001, \text{CFI} = .92, \text{TLI} = .91, \text{RMSEA} = .06, \text{SRMR} = .06$; one item on the trust and one on the communication subscales deleted due to low factor loadings); Peer attachment ($\chi^2(246) = 875.36, p < .001, \text{CFI} = .91, \text{TLI} = .90, \text{RMSEA} = .06, \text{SRMR} = .06$; one item on the alienation subscale deleted due to negative loading). Finally, 24 items of mother attachment, 23 items of father attachment, and 24 items of peer attachment were considered for further analysis. The four items that were deleted here were also deleted in the study by Zhang and colleagues (2011) where, with these items dropped, the IPPA-R showed acceptable levels of construct and criterion validity (Zhang et al., 2011), supporting its adequacy for assessing the theoretical constructs it consists of. In the present study, all CFAs indicated acceptable fit to the data, and were similar to the CFA results from Zhang and colleagues (2011). Global and subscale internal consistencies were for Mother (global $\alpha = .91$; trust $\alpha = .86$; communication $\alpha = .83$; alienation $\alpha = .69$), for Father (global $\alpha = .93$; trust $\alpha = .91$; communication $\alpha = .88$; alienation $\alpha = .73$) and for Peer (global $\alpha = .93$; trust $\alpha = .91$; communication $\alpha = .90$; alienation $\alpha = .76$).

Physical self-concept was measured via the Physical Self-Perception Profile (PSPP; Fox & Corbin, 1989), a 30-item self-report questionnaire consisting of one higher-order factor physical self-worth, and its subordinate four factors: sport competence, physical conditioning (fitness), body attractiveness, physical strength (six items per subscale). Each item presents the participant with a forced choice between two contrasting statements (e.g. “I do very well at all kinds of sports” versus “I don’t do very well at all kinds of sports”), and degree of agreement (i.e. “sort of true of me” or “really true of me”). A Chinese version of PSPP was used, with acceptable
reliability ($\alpha$ values range .75 – .82) and construct and content validity (Xu & Yao, 2001). All subdomains of physical self-perception showed acceptable levels of internal consistency: sport competence $\alpha = .78$; physical conditioning $\alpha = .75$; body attractiveness $\alpha = .60$; physical strength $\alpha = .74$.

Physical activity behavior (self-reported) was measured through the Physical Activity Questionnaire for Adolescents (PAQ-A; Kowalski, Crocker, & Donen, 2004), a 7-day recall questionnaire consisting of 9 items, e.g. “In the last 7 days, during your physical education classes, how often were you very active (playing hard, running, jumping, throwing)?” responded to on a 5-point scale with higher scores indicating higher levels of PA behavior. Satisfactory validity and reliability have been reported for the PAQ-A (Kowalski, Crocker, & Kowalski, 1997) and for the Chinese version (Hsieh, 2006) used here, for which reliability $\alpha$ values ranged between .50 and .84 (Hsieh, 2006). The internal consistency of the questionnaire in the current study was $\alpha = .83$.

**Procedure and data analysis**

Upon approval by the University Research Ethics Board, school principals, head teachers and students were informed about the purpose of the study and that participation was voluntary and anonymous. Informed consent contracts for parents were distributed and passive consent was obtained from parents while verbal consent was obtained from all participating students. A week later, the questionnaire was administered to the students during class. Test administrators took charge of entire class sessions, being available to answer questions. Prior to completing the questionnaires, participants were reassured again that their answers were entirely anonymous and would not influence their grades. The questionnaire took approximately 40 minutes to complete.
The response rate was 98.99% (783 of 791 administered questionnaires were returned). Data screening revealed 14 incomplete cases and 2 cases with outliers, all of which were excluded, leaving responses from 767 participants (375 male, 369 female, 23 not reporting gender) for analysis. Expectation-maximization (EM) was used to replace missing values in the remaining cases, as analysis demonstrated that data was missed at random (MAR; Bennett, 2001) and variables were missing less than 5% of values.

First, means, standard deviations, and correlations among the study variables were calculated. Next, structural equation modeling (SEM) was used for primary analyses. The method of item parceling was employed considering the complexity of the proposed model. Item parceling enables the creation of a more parsimonious model by reducing the number of parameter estimates required to reflect a construct definition and overall fit of model representation. Moreover, aggregate-level scores can enhance the reliability and communality, increase the ratio of common-unique factor variance, and decrease the likelihood of distributional violations as well as various sources of sampling error (Little, Cunningham, Shahar, & Widaman, 2002). Although item parceling in SEM remains a controversial issue, the use of parcels was deemed suitable here as the focus was on the correlations among latent factors rather than on the relations among specific items. Following Ullrich-French and colleagues’ (2011) suggestions, three items were randomly selected from each subscale (trust, communication, and alienation) to create three sets of indicators for each attachment relationship, respectively. Regarding each indicator of attachment relationship, an attachment security score was calculated through subtracting the alienation score from the sum of trust and communication scores. The three resulting attachment security scores played as observed indicators of attachment relationships with mother, father, and friend,
respectively, in SEM. Similarly, the six items within each subscale of physical self-concept were parceled into three indicators representing sport competence, physical conditioning, body attractiveness, and physical strength, respectively. All parcels were generated by calculating the average score of two randomly assigned items. Parcelling strategy of items in sub-dimensions of physical self-concept had been used elsewhere (Cumming et al., 2011). Nine items measuring PA behavior served as observed indicators of PA.

SEM models examined the mediation effects of physical self-concept using the bootstrapping procedure outlined by Preacher and Hayes (2008), with 5000 bootstrap samples and estimates of indirect effects. A sampling distribution of the indirect effect was yielded, allowing for the output of point estimate, standard error, and bias-corrected (BC) confidence interval of the mediation effect. Bootstrapping allows for higher analytical power combined with lower risk of committing Type I error when testing indirect effects (Briggs, 2006; Preacher & Hayes, 2008). BC 95% confidence intervals were used in the present study for identifying significant mediation effects (Preacher & Hayes, 2004, 2008). Furthermore, the chi-square statistic ($\chi^2$), the comparative fit index (CFI), the Tucker-Lewis index (TLI), the root mean square error of approximation (RMSEA), and the standardized root mean square residual (SRMR) were adopted to evaluate the adequacy of the measurement CFA model and SEM models (Hu & Bentler, 1999).

Multi-group SEM was used to explore the moderating effects of gender among the study variables based on the procedures outlined by Bentler (1995). First, a baseline model with no parameter constraints was tested, followed by models in which factor loadings, factor variances, and path coefficients were progressively more constrained to be equal across gender groups. Chi-square difference test with significant $p$ value from one model to the next more constrained
model was used to indicate that the constrained parameters were not invariant across gender.

RESULTS

Descriptive statistics and correlations among the study variables are presented in Table 1, separately for female and male participants, and for the entire sample. Participants reported relatively low levels of PA and moderate to high levels of attachment security to mother, father, and friend; slightly higher scores were recorded for attachment with friends. Participants’ scores on physical self-perception were low to moderate along all five dimensions. Attachment security was positively associated with all subdomains of physical self-perception and PA, and all subdomains of physical self-perception were positively associated to PA, with correlations varying from low to moderate.

[Table 1 near here]

Gender differences were observed on all measured variables except attachment security with respect to mother and father (MANOVA Wilks’ Lambda = .87, \( F(9, 734) = 12.21, p < 0.001 \), partial \( \eta^2 = .13 \)). Male participants reported lower peer attachment (\( F(1,742)=24.81, p < .001 \), partial \( \eta^2 = .03 \)) and higher sport competence (\( F(1,742)=28.17, p < .001 \), partial \( \eta^2 = .04 \)), physical conditioning (\( F(1,742)=20.95, p < .001 \), partial \( \eta^2 = .03 \)), body attractiveness (\( F(1,742)=17.56, p < .001 \), partial \( \eta^2 = .02 \)), physical strength (\( F(1,742)=24.90, p < .001 \), partial \( \eta^2 = .03 \)), and physical activity behavior (\( F(1,742)=50.96, p < .001 \), partial \( \eta^2 = .06 \)).

Mediational role of physical self-perception

Robust maximum likelihood (MLR) analysis was employed to estimate the measurement model and SEM analyses as not all the data was normally distributed (normalized multivariate skewness = 36.18, \( p < .0001 \); normalized multivariate kurtosis = 628.62, \( p < .0001 \)). First, a
higher-order full measurement model was tested based on 30 observed indicators (3 indicators for each attachment relationship, 3 indicators for SC, 3 indicators for PC, 3 indicators for BA, 3 indicators for PS, and 9 indicators for PA) and nine latent constructs, with four first-order physical self-perception subdomains (SC, PC, BA, and PS) loading on a second-order physical self-perception factor. Second, a first-order full measurement model collapsing the higher-order physical self-perception factor was examined. The results from these CFA revealed appropriate fit of the global measurement model to the data ($\chi^2 (390) = 803.73, p < .001$, CFI = .96, TLI = .95, RMSEA = .04, CI = [.03, .04], SRMR = .05; $\chi^2 (375) = 738.07, p < .001$, CFI = .96, TLI = .96, RMSEA = .04, CI = [.03, .04], SRMR = .04). All indicators loaded significantly onto their respective latent variables ($p < .01$).

**Higher-order factors model.** The model for assessing the mediation role of general physical self-perception revealed satisfactory fit indexes ($\chi^2 (389) = 768.93, p < .001$, CFI = .96, TLI = .96, RMSEA = .04, CI = [.03, .04], SRMR = .05). Mother and friend attachment security were positively associated with physical self-perception ($\beta = .23, p < .01; \beta = .14, p < .01$). In turn, physical self-perception was positively associated with PA ($\beta = .51, p < .01$). Using bootstrapping, indirect effects of physical self-perception were found for mother and friend attachment security and PA, supporting indirect-only (full) mediation (Table 2). Attachment security in relation to father was not associated with physical self-perception ($\beta = .06, p > .05$) but a significant direct effect was revealed between father attachment security and PA ($\beta = .15, p < .01$). The parsimonious model (Fig. 1a) excluding the three non-significant paths (from father attachment to physical self-perception; from mother and friend attachment to PA) provided good fit to the data ($\chi^2 (392) = 770.012, p < .001$, CFI = .96, TLI = .96, RMSEA = .04, CI = [.03, .04], SRMR = .05),
did not result in a significant change in model fit ($\Delta \chi^2_{(3)} = 1.09, p > .05$) and demonstrated meaningful prediction of PA behavior (32.0% of variance in PA explained).

[first table near here]

First-order factors model. In order to specify the relative strength of the different physical self-perception subdomains as mediators of the link between attachment and PA, a first-order factor model was tested, simultaneously assessing the multiple potential mediating effects of the four subdomains. The model demonstrated good fit to the data ($\chi^2_{(375)} = 803.60, p < .001$, CFI = .96, TLI = .95, RMSEA = .04, CI = [.035, .042], SRMR = .04). Attachment security in relation to mother and friend was positively linked to all four subdomains: sport competence ($\beta = .18, p < .01; \beta = .10, p < .05$), physical conditioning ($\beta = .25, p < .01; \beta = .17, p < .01$), body attractiveness ($\beta = .13, p < .05; \beta = .15, p < .01$), and physical strength ($\beta = .21, p < .01; \beta = .12, p < .01$). Again, attachment security in relation to father was only linked to PA directly ($\beta = .13, p < .05$). The mediating effects of the four dimensions of physical self-concept are displayed in Table 2. Only perceived physical conditioning (fitness) positively predicted PA ($\beta = .48, p < .05$) and the indirect effect of physical conditioning was significant in the link between mother attachment and PA, and friend attachment and PA, suggesting indirect-only (full) mediation. The parsimonious model (Fig. 1b), excluding all non-significant paths (from father attachment to four subscales of physical self-concept; from mother and friend attachment to PA), provided good fit to the data ($\chi^2_{(381)} = 810.33, p < .001$, CFI = .96, TLI = .96, RMSEA = .04, CI = [.035, .042], SRMR = .04) and did not result in a significant change in model fit ($\Delta \chi^2_{(6)} = 6.73, p > .05$). The model demonstrated meaningful prediction of PA behavior (31.9% of variance in PA explained).

Two alternative SEM models to the one hypothesized were tested: An inverse first-order
model with PA predicting attachment relationships via the four dimensions of physical
self-perception fit the data equally well as the proposed model ($\chi^2 (375) = 803.60, p < .001, \text{CFI} = .96, \text{TLI} = .95, \text{RMSEA} = .04, \text{CI} = [.035, .042], \text{SRMR} = .04$). PA was positively associated
with four dimensions of physical self-perception: sport competence ($\beta = .49, p < .01$), physical
conditioning ($\beta = .56, p < .01$), body attractiveness ($\beta = .42, p < .01$), and physical strength ($\beta = .49, p < .01$). Physical conditioning, in turn, significantly affected attachment security to mother
($\beta = .68, p < .01$), father ($\beta = .66, p < .01$), and friend ($\beta = .55, p < .01$); while sport competence
was negatively associated with attachment security to mother ($\beta = -.28, p < .05$) and father ($\beta =
-.31, p < .05$). PA was also found to be directly linked to father attachment ($\beta = .16, p < .01$).

Another alternative model hypothesizing attachment security predicting physical self-perception
via levels of engagement in PA behavior also fit the data equally well ($\chi^2 (389) = 836.69, p < .001,
\text{CFI} = .96, \text{TLI} = .95, \text{RMSEA} = .04, \text{CI} = [.035, .042], \text{SRMR} = .05$). Attachment security in
relation to mother, father, and friend, respectively, were positively linked to PA ($\beta = .12, p < .05; \beta
= .18, p < .01; \beta = .09, p < .05$), and PA, in turn, positively influenced physical self-perception ($\beta
= .50, p < .01$). Mother and friend attachment were also directly associated with physical
self-perception ($\beta = .17, p < .01; \beta = .10, p < .05$). Additionally, PA acted as full mediation in the
link between father attachment and physical self-perception ($\beta = .024, \text{SE} = .007, p < .01, \text{BC 95%}
\text{CI} [.010, .040]$), and partial mediation between mother attachment and physical self-perception ($\beta
= .017, \text{SE} = .008, p < .01, \text{BC 95% CI} [.001, .033]$), and friend attachment and physical
self-perception ($\beta = .012, \text{SE} = .006, p < .01, \text{BC 95% CI} [.001, .024]$).

[Figure 1a & 1b near here]

Gender differences. Since there were gender differences with respect to physical
self-perception and self-reported PA behavior, multi-group SEM analyses were finally conducted, in order to examine whether the specified relations in the model were moderated by gender. The baseline models produced satisfactory fit indices overall (male: $\chi^2_{(390)} = 598.72$, $p < .001$, CFI = .95, TLI = .95, RMSEA = .04, CI = [.03, .04], SRMR = .05; female: $\chi^2_{(389)} = 596.25$, $p < .001$, CFI = .96, TLI = .95, RMSEA = .04, CI = [.03, .04], SRMR = .05), but the initial analysis for males and females, separately, indicated that gender moderated the effect of mother attachment on physical self-perception and the effect of father attachment on PA, with path from mother attachment to physical self-perception significant for females ($\gamma = .24$, $p < .01$) but not males ($\gamma = .13$, $p > .05$), and with path from father attachment to PA significant for males ($\gamma = .20$, $p < .05$) but not females ($\gamma = .11$, $p > .05$). Thus, these two paths were not constrained in the final step of regression coefficients’ invariant testing. To test the effect of gender on other specified paths, a series of increasingly constrained model were conducted. The configurable baseline model demonstrated acceptable fit to the data ($\chi^2_{(779)} = 1194.97$, $p < .001$, CFI = .96, TLI = .95, RMSEA = .04, CI = [.03, .04], SRMR = .05), and the model with factor loadings equally constrained across gender also provided an acceptable fit ($\chi^2_{(804)} = 1219.10$, $p < .001$, CFI = .96, TLI = .95, RMSEA = .04, CI = [.03, .04], SRMR = .05), no different from the baseline model ($\Delta \chi^2_{(25)} = 24.13$, $p > .05$). A better model was obtained by releasing the four factor variances that differed across gender groups ($\chi^2_{(809)} = 1229.51$, $p < .001$, CFI = .96, TLI = .95, RMSEA = .04, CI = [.03, .04], SRMR = .06) and was no different from the model with only factor loading constrained ($\Delta \chi^2_{(5)} = 10.41$, $p > .05$). Finally, the model imposing the equality constraints of the regression parameters linking the latent factors across male and female groups showed acceptable fit to the data ($\chi^2_{(814)} = 1235.64$, $p < .001$, CFI = .96, TLI = .95, RMSEA = .04, CI = [.03, .04], SRMR = .06), and gender
invariance ($\Delta \chi^2(5) = 6.13, p > .05$). Therefore, the specified relations in the model did not show

gender differences except the link between mother attachment and physical self-perception, and

between father attachment and PA.

**DISCUSSION**

The present study was the first to test associations between PA behavior during adolescence

and degree of perceived attachment security in multiple relations, regarding attachment to mother,

father, and best friend separately, and verify the mediating role of physical self-perception in this

association. Specifically, we found significant indirect influences from attachment security in

relation to mother and friend, respectively, to participation in PA, which were mediated by

physical self-perception. By contrast, results suggest a unique direct contribution of attachment

security in relation to father, for increased levels of PA in adolescence. Importantly, it appears that

the path of attachment security to mother impacting levels of PA through the mediation of physical

self-perception is strongest for female adolescents, while the path of attachment security to father

directly impacting levels of PA is strongest for male adolescents. Previous studies linking

attachment style to health behavior in the specific domain of PA have been sparse and few have

explored multiple relationships simultaneously. Knowledge of the specific ways in which each of

these three relationships are associated to PA behavior, in combination with increased

understanding of potential underlying psychological mechanisms, can have significant

implications for PA interventions and public health ramifications concerning adolescent PA.

Results from the present study can guide relationship based PA interventions in the choices of how

to best engage parents and peers.

Consistent with previous research, our findings confirm the strong positive link between
physical self-perception and self-reported PA behavior (Babic et al., 2014; Crocker et al., 2006; Fox & Corbin, 1989; Lindwall & Hassmén, 2004; Raudsepp et al., 2013). At least among young adolescents, engagement in PA appears to be closely linked to a perception of self as fit, strong and a good performer in sport. The causal path in this relationship could nevertheless be bidirectional: As hypothesized, self-perceptions of fitness, strength and ability in sport may result in the adolescent feeling confident in engaging in PA, or even require that the adolescent engages in PA in order to maintain this self-perception and self-image. Alternatively, in line with previous suggestions (Crocker et al., 2006), high engagement in PA behavior could result in self-perceptions of being fitter, stronger and more sport-capable, a case of reality confounding self-perception. Outcomes from long-term exercise intervention studies corroborate this alternative suggestion, as increased engagement in PA did result in small improvements of physical self-perception through the perception of increased fitness (Lindwall & Lindgren, 2005; Schneider, Dunton, & Cooper, 2008). Results from a recently published study, testing longitudinal associations between sport participation and self-esteem, underline the importance of taking into consideration a possible bi-directional link between physical self-perception and PA as well as of interactions between age and the direction of effects (Wagnsson, Lindwall, & Gustafsson, 2014).

Limited by its design, the present study could not distinguish between these two possibilities. Longitudinal studies focusing on the temporal precedence among these variables are necessary in order to reveal the direction of causality in these relationships, ideally tracking changes from early childhood through to late adolescence.

Attachment security in relation to mother, father and friend, respectively, was associated with greater PA engagement, consistent with other findings (Pietromonaco & Uchino, 2013;
Ullrich-French, Smith, & Cox, 2011). Partly confirming our hypothesis, physical self-perception fully mediated this association concerning secure attachment to mother and friend suggesting that, indeed, attachment-related influences are of importance for valued outcomes in the context of PA among adolescents, and that these influences may be explained by the impact of attachment security on physical self-perception. Our results are in line with the tenets of attachment theory, that securely attached children develop positive representations of themselves that nurture the formation of positive self-perception (Aldhafri, 2011) and that feelings of self-worth largely depend on quality of the attachment relationship with the primary caregiver (e.g. Cassidy, 1988).

Notably, there was no mediation of physical self-perception in the link between attachment security to father and PA behavior in the adolescents, consistent with the assertion that self-perception in various specific domains is likely to be influenced by different unique social relationships (Jowett & Cramer, 2010; Verschueren, Doumen, & Buyse, 2012). Assuming it is more likely that mothers were the primary caregivers of the adolescents in our sample, security in the mother-child relationship would indeed emerge as particularly important for the adolescent’s positive self-perception and subsequent PA behavior. Differences in the typical roles of father and mother associated with specific features in the Chinese culture, where mothers are expected to be expressively caring and loving, impacting on children’s self-perception, while fathers are responsible for making demands for achievement and promoting their life satisfaction (Stewart et al., 2002), may be another plausible explanation for this findings.

Instead, a direct link between attachment security in relation to father and engagement in PA behavior was found. This is consistent with findings by Lau and colleagues (2007), who showed that fathers as role models had a dominant and direct effect on Chinese children’s attraction to PA.
Findings from a similar western study also show that father modeling is directly linked to children’s PA, whereas mother modeling is linked to children’s PA through the mediation of perceived competence and attractiveness to PA (Määttä, Ray, & Roos, 2014). The importance of father as practically supporting exploratory behavior, and as often engaging in physical activity together with the child has also been reported elsewhere (Beets, Cardinal, & Alderman, 2010; Tomasello, Conti-Ramsden, & Ewert, 1990). Finally, mothers’ and fathers’ different influence patterns could also mirror traditional mother and father roles: The father as breadwinner, often away during weekdays and engaging in sport together with the child during weekends, the mother helping out during the entire week to plan, transport and support the child in relation to physical activity and sport (Beets et al., 2010). With new family constellations and a more gender equal society, these different paths of influence of mother and father attachment on adolescent PA may come to be revised in the future.

Most importantly, gender moderated the strength of two different paths of links between attachment security and PA levels. The direct link between attachment security in relation to father and the adolescent’s engagement in PA behavior was stronger for boys, compared to girls, possibly indicating that, especially in secure father-child relationships fathers provide support for exploratory behavior and are more likely to engage in physical interaction with their adolescent sons, not daughters. Moreover, the role modelling mediated links between father and PA in children reported elsewhere (Lau et al., 2007; Määttä et al., 2014) may be of higher strength for father –son (same sex modelling) than for father daughter (different sex modelling). The indirect link between attachment security in relation to mother and PA levels, through the mediation of physical self-perception, was present for adolescent girls but not boys, consistent with other
research (Song, Thompson & Ferrer, 2009). This finding could be partly reflecting the large
differences, between adolescent boys and girls, in how the self is perceived and evaluated
(Mäkinen, Puukko-Viertomies, Lindberg, Siimes, & Aalberg, 2012; Rawana & Morgan, 2014),
also corroborated in the present study, as girls held significantly more negative physical
self-perceptions than boys. Attachment security in a trustful and supportive relationship with the
mother may protect from negative self-evaluation, resulting in a more positive physical
self-perception and therefore higher levels of PA for the adolescent girl.

Attachment to friend had a unique contribution to adolescents’ PA, mediated by physical
self-perception. Friendship in the physical activity domain is of particular importance for
understanding motivation in youth sport (e.g., Allen, 2003). There is growing evidence indicating
strong peer influences in shaping positive self-perceptions that affect response and motivation
related to PA (e.g., Smith, 1999; Smith & McDonough, 2008). Smith (1999) tested a model
examining associations among peer relationships (including friendship and peer acceptance),
physical self-worth, motivation, and PA behavior and showed that peer acceptance was positively
associated with PA behavior via the mediation of physical self-worth. The current findings extend
this notion, showing that a secure attachment with a close friend, beyond the scope of peer
acceptance, is critical for young people’s engagement in PA (Smith, 2003).

Among components of physical self-worth, perceived physical conditioning was the strongest
mediator of the link between attachment security and PA, in line with research underlining the
differential importance of specific subdomains of physical self-perception for PA in adolescents
(e.g., Crocker et al., 2006; Lindwall & Hassmén, 2004; Raudsepp et al., 2013). Physical
conditioning captures the perceived state of the body and it’s functioning, reflecting how
physically fit the individual perceives him- or herself to be (Fox & Corbin, 1989). If physical conditioning were to be placed into one of the subdomains used by Babic and colleagues (2014) (perceived competence, perceived fitness or perceived appearance), the closest fit would be “perceived fitness”. However, the meta-analytic review by Babic and colleagues (2014) pointed to perceived sport competence as the strongest correlate of PA. In addition, previous research on female adolescents has highlighted body attractiveness as the strongest mediator, among physical self-perception subdomains, in the relationship between maturity status and PA (Cumming et al., 2011). Possibly, gender differences with respect to this confound current research evidence, as the distinct impact of sport competence and physical conditioning for PA has been previously shown in adolescent girls (Crocker et al., 2006), while Babic and colleagues (2014) suggest that the link between general physical self-perception and PA is stronger among boys. Although the present study could not confirm gender differences in the significance of the different subdomains of physical self-perception and PA, the importance of the subdomain “physical conditioning” as a mediator of the relation between attachment and PA may have practical implications. To increase feelings of physical fitness and pride, the perspective of sport and performance may need to be complemented with that of daily physical activity and exercise from a well-being perspective. In addition, instant constructive feedback and praise of physical activity, exercise and sport needs to be complemented by reflecting an understanding of the importance of early-life relationships for feelings of physical pride and respect for the self among children and adolescents.

Limitations and suggestions for future research

Notwithstanding its strengths, there are limitations to the present study. First, during transition to early adolescence, the influence of attachment relationships on physical self-perception and PA
behavior, and the effect of physical self-perception on PA behavior, represent a dynamic process over time. The cross-sectional design of the present study did not allow an investigation of the temporal precedence among the variables. Future longitudinal investigations and assessments of intervention programs will hopefully further our understanding of the causal relationships linking physical self-perception to PA during late childhood and adolescence. Particularly the understanding of the mechanisms resulting in the direct impact of attachment security, with respect to father, on PA levels in adolescence would require longitudinal investigations of longer term, with start already in early childhood, and a sensitive focus on the type and nature of interactions between father and child such that promote the child’s PA behavior later on in life.

An inverse first-order model with PA predicting attachment relationships via the four dimensions of physical self-perception was examined, which fit the data equally well as the proposed model. The theoretical plausibility of such a causal path is nevertheless very low, as it is well established that attachment representations develop during early childhood, are strengthened during late childhood, and are relatively stable over time. And the relations between the variables in this alternative model were unreasonable (i.e. negative association between sport competence and attachment relationships). Another alternative model hypothesizing that attachment security predicts physical self-perception via levels of engagement in PA behavior fit the data equally well (having the same fit indices), supporting Crocker and colleagues’ (2006) previous suggestion. However, these findings were expected from a mathematical point of view: as our proposed model was relatively saturated, the fit indices for the data would likely be similar independently of the order of the latent variables (Lee & Hershberger, 1990). The question of causality can thus utterly be answered only via longitudinal or intervention designs.
Participants in the present study were in the developmental stage of early adolescence and more research is necessary in order to assess whether the specified relations hold for other age groups. Other age groups, such as university students, would be of empirical interest because of the transition from high school to college usually give rise to changes in patterns of social relations and health behavior (Ullrich-French, Smith, & Cox, 2011; Huntsinger & Luecken, 2004). Finally, the measures employed here performed well in terms of reliability, with the exception of the body attractiveness subscale that did not show high reliability, perhaps due to the wording problem of the translated version of PSPP. Further adjustment and validation of the Chinese version of PSPP is necessary in order to improve measurement precision.

To sum up, the present study extends the understanding of physical activity in adolescents from an integrated theoretical perspective, combining attachment security and self-perception in the physical domain. Multiple important relationships were studied simultaneously, in order to form a more comprehensive picture of social influence on adolescents’ physical activity, compared to previous studies. The findings of this study suggest that secure attachment to mother, father, and friends, separately, have a positive influence on physical activity behavior directly, or indirectly, through physical self-perception. These findings highlight the usefulness of attachment theory, and the concept of attachment security, for a better understanding of how relatedness may be conceptualized and actualized in explanation theories and interventions for promoting PA in youth. Acknowledging the importance of positive relations (secure attachments), in which caregivers and friends communicate approval and acceptance of the adolescent’s physical self needs to be considered within future PA interventions. Since the paths linking attachment security in relation to parent and adolescent PA levels appear to vary according to gender of both
adolescent and parent, gender ought to be taken into consideration when designing parent-child activities for intervention programs to help adolescents enhance and maintain a physically active lifestyle.

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<table>
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<tr>
<th>Variable</th>
<th>Range</th>
<th>$M_{\text{Male}}$ (SD)</th>
<th>$M_{\text{Female}}$ (SD)</th>
<th>$M_{\text{Total}}$ (SD)</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
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<td>(1) Mother</td>
<td>-3 to 9</td>
<td>4.46 (1.83)</td>
<td>4.62 (2.62)</td>
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<td>–</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td>(2) Father</td>
<td>-3 to 9</td>
<td>4.40 (2.17)</td>
<td>4.30 (2.28)</td>
<td>4.32 (2.23)</td>
<td>.49**</td>
<td>–</td>
<td></td>
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<tr>
<td>(3) Peer</td>
<td>-3 to 9</td>
<td>4.83 (1.96)</td>
<td>5.53 (1.88)</td>
<td>5.17 (1.95)</td>
<td>.29**</td>
<td>.32**</td>
<td>–</td>
<td></td>
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<td>(4) SC</td>
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<td>2.45 (.69)</td>
<td>2.17 (.74)</td>
<td>2.31 (.72)</td>
<td>.17**</td>
<td>.12*</td>
<td>.13**</td>
<td>–</td>
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<td>(5) PC</td>
<td>1 – 4</td>
<td>2.77 (.70)</td>
<td>2.51 (.79)</td>
<td>2.63 (.75)</td>
<td>.27**</td>
<td>.23**</td>
<td>.22**</td>
<td>.70**</td>
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<td>(6) BA</td>
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<td>2.37 (.56)</td>
<td>2.19 (.60)</td>
<td>2.28 (.58)</td>
<td>.15**</td>
<td>.12*</td>
<td>.13**</td>
<td>.51**</td>
<td>.52**</td>
<td>–</td>
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<tr>
<td>(7) PS</td>
<td>1 – 4</td>
<td>2.61 (.66)</td>
<td>2.37 (.69)</td>
<td>2.48 (.68)</td>
<td>.17**</td>
<td>.11*</td>
<td>.13**</td>
<td>.72**</td>
<td>.70**</td>
<td>.51**</td>
<td>–</td>
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<td>(8) PA</td>
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<td>2.02 (.54)</td>
<td>2.17 (.60)</td>
<td>.17**</td>
<td>.22**</td>
<td>.13**</td>
<td>.37**</td>
<td>.39**</td>
<td>.32**</td>
<td>.36**</td>
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</table>

Notes. Mother = security attachment to mother; Father = security attachment to father; Peer = security attachment to peer; SC = sport competence; PC = physical conditioning; BA = body attractiveness; PS = physical strength; PA = physical activity.

*p < .005, **p < .001 (two-tailed).
Table 2. Bootstrap analysis summary showing the indirect effects of attachment security on PA via general physical self-worth and all subscales of physical self-concept.

<table>
<thead>
<tr>
<th>Path</th>
<th>a path coefficient (IV-MV)</th>
<th>b path coefficient (MV-DV)</th>
<th>c’ path coefficient (direct effect)</th>
<th>Product-of-Coefficient (indirect effect, axb)</th>
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<td></td>
<td></td>
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<tr>
<td>Mother-PSW-PA</td>
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<td>0.285*</td>
<td>0.001</td>
<td>0.018</td>
</tr>
<tr>
<td>Father-PSW-PA</td>
<td>0.015</td>
<td>0.285*</td>
<td>0.022</td>
<td>0.004</td>
</tr>
<tr>
<td>Friend-PSW-PA</td>
<td>0.038*</td>
<td>0.285*</td>
<td>0.003</td>
<td>0.011</td>
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<tr>
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<td>0.045</td>
<td>-0.001</td>
<td>0.003</td>
</tr>
<tr>
<td>Mother-PC-PA</td>
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<td>0.254*</td>
<td>-0.001</td>
<td>0.019</td>
</tr>
<tr>
<td>Mother-BA-PA</td>
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<td>0.042</td>
<td>-0.001</td>
<td>0.001</td>
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<tr>
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</table>

Notes. These values are from unstandardized path coefficient. PSW=Physical self-worth; SC=Sport competence; PC=Physical conditioning; BA=Body attractiveness; PS=Physical strength; PA=Physical activity. *p < .05.
Figure 1a. The parsimonious higher-order model describing mediation of physical self-perception in the link between attachment security and PA.

Notes. Only significant paths and standardized path coefficients are presented. Indicators are not presented for simplicity (all indicators loaded significantly on their respective factors).

**p < .01.

Figure 1b. The parsimonious first-order model describing mediation of the four subdomains of physical self-perception in the link between attachment security and PA.

Notes. Only significant paths and standardized path coefficients are presented. Indicators are not presented for simplicity (all indicators loaded significantly on their respective factors). Inter-correlations of the four subdomains of physical self-perception were: SC vs. PC (r = .86); SC vs. BA (r = .65); SC vs. PS (r = .87); PC vs. BA (r = .68); PC vs. PS (r = .89); BA vs. PS (r = .68).

*p < .05, **p < .01.
Attachment security with respect to mother and friend predicted PA via the mediation of physical self-perception.

Attachment security with respect to father was directly related to adolescents’ PA.

Important gender differences emerged: The first path was strongest for girls while the second path was strongest for boys.

The physical conditioning (fitness) dimension of physical self-perception was the only significant mediator in the link between attachment security and PA.