INFLUENCE OF BEST FRIENDS ON CHILDREN'S ATHLETIC COMPETENCE AND PHYSICAL ACTIVITY ENGAGEMENT: A LONGITUDINAL ANALYSIS

By

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Abstract

Pediatric obesity is a significant public health concern, associated with systemic physical health repercussions and impairing social and emotional consequences. Physical activity is an important protective factor against development of obesity, and childhood represents a critical time for forming lifelong physical activity habits. Weight status has been shown in the adult and adolescent literature to move through social systems as a “social contagion”, yet the social systems on development of physical activity and athletic competence in childhood has been less studied, especially within a longitudinal frame. This study aimed to examine the influence of perceived and self-reported best friend factors on child physical activity and athletic competence over a school year. Methods included in-school administration of questionnaires related to athletic competence and perceived best friend athletic competence, as well as objective measurement of physical activity. Findings suggested friends were similar on these constructs at Time 1, but not Time 2. The novel measurement of perceived best friend athletic competence was revealed to be a unique and influential construct. This variable was distinct from both child self-reported athletic competence and best friend self-reported athletic competence, and significantly influenced child engagement in physical activity over time. Implications for this study include the importance of measuring the child’s perception of the best friend when examining dyads in the context of physical activity.

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Introduction

As noted by both the current and prior U.S. Surgeons General, pediatric obesity is a significant public health concern (U.S. Department of Health and Human Services, 2010; U.S. Department of Health and Human Services, 2001). Recent estimates indicate that approximately one out of every six children in the U.S. is obese [i.e., body mass index (BMI) > 95^{th} percentile] and that approximately one out of every three children in the U.S. is overweight (i.e., BMI > 85^{th} percentile; Ogden, Carroll, Kit, & Fegal, 2012). These estimates suggest that there has been a threefold increase in the prevalence of pediatric obesity in the last three decades, although current estimates suggest the trend may be stabilizing.

Pediatric obesity is associated with significant physical and health consequences. Many body systems are negatively affected by excess adiposity, including the cardiovascular, metabolic, pulmonary, gastrointestinal, and skeletal systems (Daniels, 2006). A recent systematic review provides evidence of a strong association between pediatric obesity and later diabetes, stroke, coronary heart disease, hypertension, as well as premature mortality (Reilly & Kelly, 2011). Furthermore, obesity predicts not only poor health in childhood, but also increased risk for continued obesity and the related health problems into adulthood (Franks et al., 2010), when obesity is harder to treat and associated with more severe health repercussions (Bray, 2004).

Obesity in childhood is also associated with psychological and emotional consequences, including peer victimization (Hayden-Wade et al., 2005), fewer friendship nominations from peers (Strauss & Pollack, 2003), negative stigmatization by peers (Davison & Birch, 2004), higher rates of depression (Crow, Eisenberg, Story, & Neumark-Sztainer, 2006), and poorer quality of life in all domains (Zeller & Modi, 2006). These findings suggest that almost every aspect of a child's everyday life can be negatively affected by obesity.

Fundamentally, a child becomes obese when the "energy balance equation" becomes imbalanced, such that the child is consuming more calories than expending (Epstein & Wrotniak, 2010). While the exact nature of the energy balance equation and associated behaviors are the result of a complex and highly ideographic interaction between genetics, environment, and behaviors, regular engagement in physical activity has consistently been shown to be a powerful protective factor against pediatric obesity and a source of health and wellbeing for all children (e.g., De Bourdeaudhuij et al., 2011; Janssen et al., 2005; Timmons et al., 2012). A global systematic survey of health behaviors of youth in 34 countries found a statistically significant negative relationship between physical activity participation and BMI classification, such that the risk of being overweight decreased in a dose-response manner with higher physical activity across countries and cultures (Janssen et al., 2005).

Regular engagement in physical activity has health benefits above and beyond simple weight reduction. According to one recent systematic review, there is "irrefutable evidence" of the benefits of regular physical activity in preventing numerous chronic health conditions, including cardiovascular disease, diabetes, cancer, hypertension, depression, osteoporosis, and even premature death (Warburton, Nicol, & Bredin, 2006, p. 801). A direct and linear relationship appears to exist between amount and intensity of physical activity and reduction of risk for health concerns, including obesity. Furthermore, engagement in physical activity represents a risk factor that is modifiable and under the influence of the individual.

An active lifestyle may even reduce the impact of a genetic predisposition for obesity, a factor that was thought of as unmodifiable until recently. A recent groundbreaking study of adults found that each additional obesity-susceptibility allele in a person's genetic makeup is associated with an increase in BMI (Li et al., 2010). However, for physically active adults, the increase in weight status per obesity-susceptibility allele was 36% lower than in inactive adults, indicating that regular physical activity can interact with a person's genetic expression to reduce the impact of a genetic predisposition for obesity. Current research suggests that this interaction may not be present to the same degree in children and adolescents (Kilpelainen et al., 2011); however, these findings make a strong case for the importance of developing lifelong physical activity habits in childhood.

Childhood appears to be a critical period in the development of physical activity behaviors. A recent 21-year tracking study of physical activity engagement from childhood into adulthood found that high levels of continuous physical activity in childhood and adolescence significantly predicted adult engagement in physical activity (Telama, Yang, Viikari, Wanne, & Raitakari, 2005). A recent systematic review of studies tracking physical activity over time found that activity patterns in childhood were less robustly related to activity patterns in adulthood than were activity patterns in adolescence, suggesting that childhood is an important window to set the child on an active path before behaviors become more ingrained (Craigie, Lake, Kelly, Adamson, & Mathers, 2011). Studies such as these lead the Center for Disease Control (CDC) to recommend that all children should participate in at least 60 minutes of moderate-to-vigorous physical activity each day (CDC, 2012).

Despite the importance of early engagement in physical activity, the evidence indicates a substantial disconnect between what is recommended by the scientific community and actual trends of physical activity in the population. A landmark study following girls from ages nine to 19 found substantial decreases in physical activity from childhood through adolescence; Kimm et al. (2002) reported a 100 percent decline in physical activity engagement for black girls and a 64 percent decrease in physical activity for white girls. Overall, girls in this study evidenced about 29 metabolic equivalent of task (MET) units per week at ages 9-10 and fewer than 10 MET units per week at age 16-17. By ages 16-17, 56 percent of black girls and 31 percent of white girls reported no regular physical activity engagement. These findings are consistent with a large nationally-represented epidemiological study which found that only 42% of children currently achieved 60 minutes of moderate-to-vigorous physical activity per day, and this percentage plummeted to only 8% in adolescence (CDC, 2012). A second epidemiological study found that, between ages 9-15, weekday vigorous physical activity decreased by 38 minutes per year and weekend mean vigorous physical activity decreased by 49 minutes per year (Nader, Bradley, Houts, McRitchie, & O'Brien, 2008). Girls crossed below the recommended 60 minutes of moderate-to-vigorous physical activity per day on weekdays at age 13.1 and boys crossed below the recommended amount at age 14.7. By age 15, only 31% of youth met physical activity guidelines on weekdays and only 17% met guidelines on weekends (Nader et al., 2008).

An ecological perspective offers a promising direction for understanding the range of contextual factors shaping health behaviors in childhood. The socioecological model of child development was introduced by Bronfenbrenner (1979) to integrate how characteristics of the person (e.g., genetics, personality) and environment interact to shape behavior, including health behavior. More recently, Harrison et al. proposed a "big picture" ecological model of pediatric obesity, designed to synthesize the current state of the literature on social systems that influence pediatric obesity across the stages of child development (i.e., The Six C's Model; Harrison et al., 2011, p. 51). Building upon Bronfenbrenner's socioecological model and Engel's biopsychosocial model (1979), Harrison proposed that the factors influencing obesigenic behaviors in childhood could be described within five “zones” of behaviors and six ecological “spheres” of influence across time (see Figure 1). The spheres of influence (e.g., child, family, community) interact across “zones” of behaviors (e.g., opportunities, resources, and practices) to shape nutrition and activity practices. These interactions fall along a developmental continuum, suggesting that the types of behaviors in which the child engages and how aspects of the environment influence the child differ as a function of the child’s age and development. The Six C’s Model is noteworthy because it has compiled and organized the most well-accepted factors contributing to childhood overweight and obesity within the current literature.

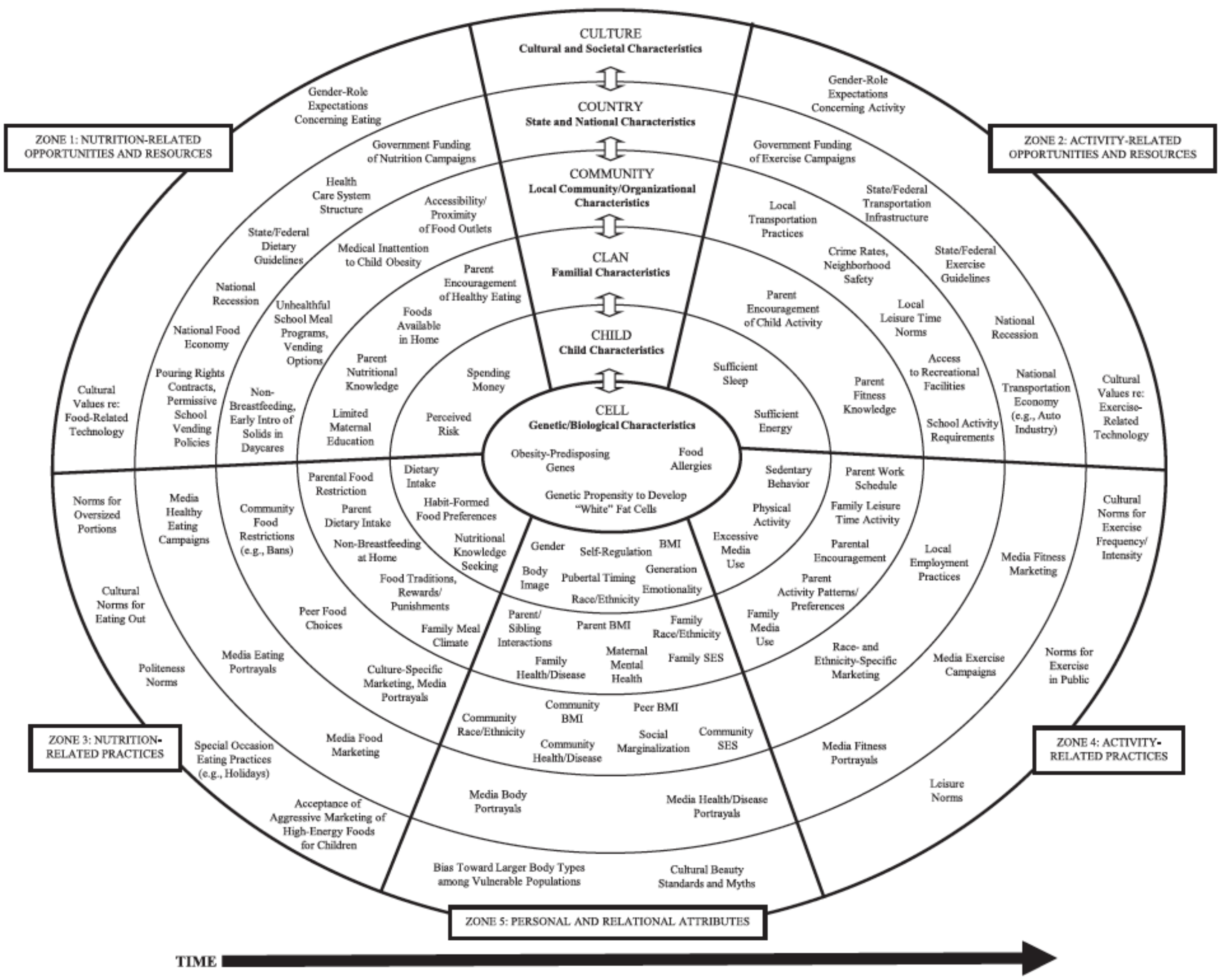

Figure 1. Harrison’s Six C’s Model of factors contributing to overweight and obesity in childhood (Harrison et al., 2011).

As demonstrated by the Six C's Model (Harrison et al., 2011) and Bronfenbrenner's model (1979) more generally, the scientific community acknowledges that social systems, and peer influences in particular, contribute to child overweight and obesity. The Six C's Model specifically provides examples of peer characteristics within the model (i.e., peer food choices, peer BMI, and local leisure time norms), communicating that peer factors are an essential component of the broad picture of ecological influences on a child's weight status.

Outside of the pediatric obesity literature, peer influences are regarded as central to understanding child development and decision-making. For example, the child friendship literature stresses that peer relationships are an essential facet of a child's social environment, often surpassing parental influence as the child approaches adolescence (Bagwell, Schmidt, & Jenchura, 2011; Hartup, 1996). Peer influences have long been regarded as central to youth engagement in deviant behaviors and health risk behaviors (e.g., drug use, sexual activity; Kandel, 1996; La Greca, Prinstein, & Fetter, 2001; Prinstein, Meade, & Cohen, 2003).

Emerging research suggests social influence may be important for obesigenic behaviors as well. For example, in a groundbreaking study, Christakis and Fowler (2007) tracked over 12,000 adults within a densely connected social network over 32 years and demonstrated that social ties were influential in the spread of obesity. In fact, a person's chances of becoming obese in the future increased by 57% if the person had a friend who became obese. These patterns were not seen within geographic clusters without strong social ties (e.g., unacquainted neighbors). Obesity spread within clusters of individuals (i.e., individuals with mutual social ties) such that an individual's chance of becoming obese increased when someone within their cluster became obese, even if the obese person was not a direct connection. These clusters of people with similar weight statuses could not be explained solely by selective formation of friends based on weight status, strongly suggesting the presence of peer influence on obesigenic behaviors.

A similar study attempted to take this concept one step further by examining social network influences on health behaviors from a controlled experimental perspective. Centola (2010) assigned adult participants to social circles within an online health forum. Even though participants did not know each other or experience contact outside of the electronic forum, individuals behaved in patterns similar to those of non-virtual social networks. That is, participants were increasingly more likely to adopt health behaviors as more individuals within their social network adopted the health behaviors, and individuals were also more likely to adopt health behaviors when the social networks were formed in clusters (i.e., groups of individuals that share connections with one another), as is typical of natural social groups, than when ties were randomly organized. These results suggest that, at least in adults, causal pathways can be understood to exist for health behaviors among peers.

In adolescents, preliminary cross-sectional social network analyses suggest similar patterns as have been found with adults. For example, multiple cross-sectional studies in adolescent samples have shown that youth who are overweight cluster in peer groups of similar weight status (e.g., Sirad et al., 2013; Trogdon, Nonnemaker, & Pais, 2008; Valente, Fujimoto, Chou, & Spruijt-Metz, 2009). Specifically, Trogdon and colleagues (2008) analyzed over 2000 adolescents and found that mean *peer* BMI was correlated with *adolescent* BMI, and the chances of an individual being overweight increased proportionally with the number of friends who were overweight. This influence seemed to be strongest among adolescents of higher weight statuses (i.e., overweight and obese). Similarly, Valente and colleagues (2009) found that overweight youth were more than twice as likely as youth of healthy weight to have friends who were overweight, and Sirad and colleagues (2013) determined that physical activity levels among adolescents were correlated with those of their friends. However, this relationship was moderated by gender; adolescent girls were more influenced by the physical activity of their peers than were adolescent boys. Such findings are consistent with the "social multiplier" idea that obesity spreads through social ties and becomes more influential as more members of the social network are obese. Indeed, the influence of social networks on obesity has been identified as one of the "biggest recent social science discoveries" and a promising new direction in childhood weight management research (Epstein & Wrotniak, 2010; p. S9).

The evidence of the influence of children's social networks on physical activity behaviors is more limited, but preliminary findings have revealed patterns consistent with the adult and adolescent weight status literature. Macdonald-Wallis, Jago, Page, Brockman, and Thompson (2011) analyzed over 500 10-11 year olds and found that children clustered into groups with others who demonstrated similar levels of both intensity and quantity of physical activity. Macdonald-Wallis and colleagues also reported that similarities among peers' levels of physical activity extended to immediate and second-degree friends (i.e., friends of friends). These patterns were significant even after controlling for gender, self-efficacy for physical activity, BMI, and socioeconomic status. These findings prompted the authors to suggest two types of friendship behavior that were likely driving this association: **influence** of friends on one another and **selection** of friends who share similar characteristics as oneself.

Several longitudinal social network analyses examining how peers impact physical activity provide additional evidence for these two pathways of influence and selection. De la Haye, Robins, Mohr, and Wilson (2010) followed over 300 adolescents over one year and found that youths emulated their friends' health behaviors (i.e., influence) and were more likely to befriend those who engaged in similar amounts of physical activity (i.e., selection). The authors noted that these processes resulted in clusters of youth with similar activity levels. Similarly, Simpkins, Schaefer, Price, and Vest (2012) assessed nearly 2000 adolescents over one year and found evidence for friend influence on physical activity, such that friends' levels of physical activity became more alike over time, and noted that this pattern was not moderated by gender, popularity, or reciprocity of friendship. They also found evidence for selection, in that youths were more likely to form new friendships with peers who had similar levels of physical activity and BMI. Gesell, Tesdahl, and Ruchman (2012) analyzed school-aged children over 6 week increments during aftercare hours. In contrast to the previous studies, these researchers did not find evidence for selection mechanisms, but found strong evidence for influence: children were six times more likely to adjust their physical activity level to match that of friends than to keep their activity level constant over time. Further, children were reported to adjust their activity level by up to 10% in order to be consistent with peers.

These examples typify the findings from a recent systematic review (Sawka, McCormack, Nettel-Aguirre, Hawe, & Doyle-Baker, 2013), which concluded that, across numerous studies, there is strong evidence for both selection and influence mechanisms of peer similarity in physical activity in youth, and also that boys tend to be influenced by their friendship network to a greater degree than girls. This review also stated that the "peer contagion model" of physical activity (i.e., influence mechanism) seems to yield a stronger effect on a child's physical activity level than whom they select as friends, which is consistent with the findings of both Gesell and colleagues (2012) and de la Haye and colleagues (2010). De la Haye and colleagues' results found that friend influence accounted for a greater proportion of the association between self and friend physical activity levels than selection, such that, at different time points, selection accounted for 11-17% of the variance between self and friend physical activity levels, while influence mechanisms accounted for 29-47% of the overall variance.

The findings summarized above are consistent with what would be predicted by both Bronfenbrenner's (1979) socioecological model and Harrison et al.'s (2011) Six C's Model. These models demonstrate that peers exert influence on the behavior of their peers generally, and on physical activity in particular. Nevertheless, the precise mechanisms by which influence operates need further clarification. Within this broad framework, mechanisms of influence between peers resonate with Social Cognitive Theory (SCT; Bandura, 1986), which posits that peers act as agents of behavior change through social interaction mechanisms such as modeling, reinforcement, and punishment. Children learn how to perform tasks from each other, and peers are the standard by which children judge their own abilities. Bandura (2004) stated that health behaviors are affected by the perceived pleasurable and aversive qualities of the behavior, and also by the social reaction they evoke. Specifically, as depicted in Figure 2, self-efficacy for the behavior (i.e., *belief in one's ability to perform the behavior*) influences behavioral outcomes through outcome expectations, goals, and sociostructural factors (e.g., peers). Within the SCT, peers who positively promote physical activity can be thought of as facilitators and those who reduce physical activity engagement can be thought of as impediments. Within the framework of peer influence on physical activity, watching a similar peer perform physical activity or receiving encouragement from a similar peer suggests that the child might be able to perform that activity and might enjoy that activity as well (see Weiss & Stuntz, 2004). Children might also feel pressure from close peers to conform to group norms in an attempt to avoid negative social consequences (see Sawka et al., 2013).

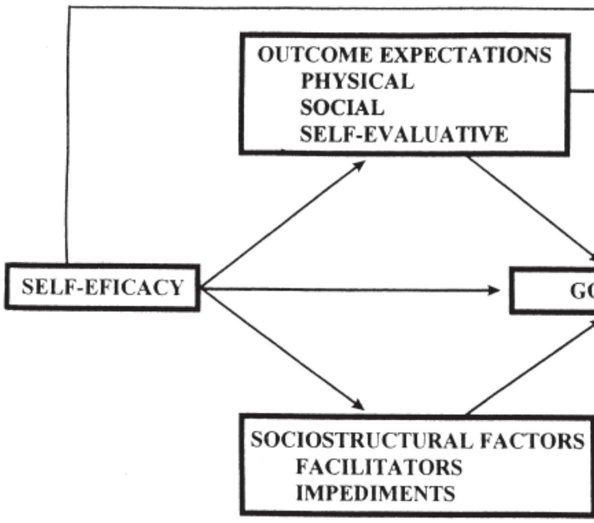

Figure 2. From Bandura (2004). Social Cognitive Theory of influence of perceived self-efficacy on health behaviors though outcome expectations, goals, and perception of facilitators and impediments.

Recent reviews have described specific detailed mechanisms by which peers may facilitate or impede physical activity behavior (Fitzgerald, Fitzgerald, & Aherne, 2012; Salvy, de la Haye, Bowker, & Hermans, 2012). Consistent with SCT, these reviews address social facilitation, peer modeling, impression management, social norms, and social support and encouragement. Each pathway represents an empirically supported mechanism by which youth are motivated by the presence of peers to change their physical activity behavior (for more information, see Bandura, 1986; Barkley, Salvy, & Roemmich, 2012; Horne, Hardman, Lowe, & Rowlands, 2009; Salvy et al., 2007; Weiss, McCullagh, Smith, & Berland, 1998; Zajonc, 1965).

The literature has also identified the quality of the peer relationship as an additional dimension of how peers affect physical activity. Friendship quality and feelings of peer acceptance seem to shed light upon whether the influence of peers is likely to be positive or negative. For example, Vilhjalmsson and Thorlindsson (1998) and colleagues studied over 1000 adolescents and found that a youth's friend's physical activity was related to one's own physical activity, *but only when the relationship was emotionally close*. This finding suggested that friend influence depends not only on the presence of a peer, but also on the quality of the relationship. Furthermore, positive friendship variables are related to engagement in physical activity, enjoyment of physical activity, and perception of athletic competence (e.g., Ullrich-French & Smith, 2009; Stuntz & Weiss, 2009; Weiss & Smith, 2002). Conversely, negative peer interactions (e.g., peer victimization) during physical activity are associated with reduced sports enjoyment and decreased engagement in physical activity (e.g., Faith et al., 2002; Jensen & Steele, 2009). However, quality alone does not seem to account for the difference in a friend being a facilitator or an impediment; Gesell et al. (2012) found that peers can adjust their activity levels either up or down to emulate those of close friends.

Despite the important role of friend quality in peer influence, only two cross-sectional studies have focused on physical activity influences in best friendships, or the peer with whom the child identifies as being closest. As a best friend is often one with whom a child spends time and values above other friends, this paucity of research is surprising. These studies of best friend influences on physical activity in children demonstrate that youth with physically active best friends and youth who engage in activity with their best friends show higher levels of physical activity themselves (Jago et al., 2011; Lopes, Gabbard, & Rodrigues, 2013). Interestingly, Lopes et al. (2013) did not find lack of reciprocity of best friend nomination to significantly diminish the power of influence.

In the SCT model, self-efficacy for the behavior is the first step towards engagement in that behavior. In the physical activity literature, athletic competence, or belief in one's ability to perform an athletic activity, is a "self-efficacy" factor. Not surprisingly, numerous studies have reported strong positive correlations between athletic competence and physical activity (Davison, Downs, & Birch, 2006; Pfeiffer, Dowda, McIver, & Pate, 2009; Stein, Fisher, Berkey, & Colditz, 2007; Welk, Wood, & Morss, 2003), suggesting that youth who believe they are capable of engaging in physical activity are more likely to actually do so.

Athletic competence seems to be particularly malleable by peer influences. Perceptions of one's own athletic competence seem to be strongly tied to social perceptions in general, according to several lines of research. A number of studies have found high correlations between peer acceptance and athletic competence (i.e., r = 0.92; Craft, Pfeiffer, & Pivarnik, 2003; r = 0.69; Vedul-Kjelsas, Sigmundsson, Stensdotter, & Haga, 2012) and youth tend to rate athletic competence as one of the most highly valued social attributes (Buchanan, Blankenbaker, & Cotton, 1976; Chase & Dummer, 1992; Eccles, Wigfield, Harold, & Blumenfeld, 1993). Knack and colleagues (2012) found that athletic competence mediated the relationship between peer rejection and peer victimization, in that youth who were athletically competent were protected from peer victimization. Furthermore, Sabiston and Crocker (2008) found that best friends held more influence than parents on a youth's perceptions of athletic competence and also found that best friends' ability and behavior were significantly correlated with the child's own athletic competence and physical activity engagement.

The current study builds upon the diverse and complex literature of peer influences on youth physical activity engagement by focusing on how perceptions of the best friend's athletic competence influence the child's athletic competence and engagement in physical activity over time. The current study provides a novel approach to this field by focusing on peer perceptions of the best friend's athletic competence as well as the best friend's self-reported athletic competence. By examining these variables over time, mechanisms of influence were examined.

The Actor-Partner Interdependence Model (APIM; Kenny, 1996) has been used with success to model dyadic influences on physical activity (Lopes et al., 2013) and dyadic influences with youth across a range of other behaviors (e.g., aggression, Adams, Bukowski, & Bagwell, 2005; home affect, Barry & Kochanska, 2010; friendship quality, Chow, Ruhl, & Buhrmester, 2013; parent-child communication, Dailey, 2008). The APIM has been described as a framework for explicitly examining mutual influences within dyadic relationships. Specifically, the APIM is designed to examine how an individual's behavior is affected not only by the individual's own characteristics, but also by the characteristics and behavior of the peer and the individual's perceptions of the peer (Kenny, 1996; Kenny, Kashy, & Cook, 2006; Little & Card, 2005). In the current study, the APIM was used as a template for examination of mechanisms of peer influence of physical activity through perceptions of the best friend's athletic competence and beliefs about a child's own athletic competence.

Specifically, it was hypothesized that the child's physical activity and best friend's physical activity levels at Time 1 would significantly predict the child's and best friend's physical activity levels at Time 2, and that the child and best friend would demonstrate more similar levels of physical activity at Time 2 than at Time 1. This hypothesis derived from the longitudinal social network literature on child physical activity (e.g., de la Haye et al., 2010; Gesell et al., 2012; Simpkins et al., 2012) and the cross-sectional best friend literature (e.g., Jago et al., 2011; Lopes, Gabbard, & Rodrigues, 2013). It was further hypothesized that a child's athletic competence would be associated with his/her perceptions of the best friend's athletic competence over time. It was predicted that the child would adapt his/her athletic competence over time in order to become closer to the perceived best friend's athletic competence between Time 1 and Time 2. This hypothesis derived from the literature reviewed on influence mechanisms and on athletic competence (e.g., Davison et al., 2006; Gesell et al., 2012), but incorporated the novel aspect of the child's perceptions of the best friend, which may be a more accurate influence on the child than the best friend's self report. Similarly, it was hypothesized that a child's athletic competence and perceived best friend's athletic competence would be associated with the child's engagement in physical activity cross-sectionally. This hypothesis sought to build upon the literature on influence mechanisms between best friends (e.g., Jago et al., 2011; Lopes, Gabbard, & Rodrigues, 2013).

Method

Participants.

Participants included third, fourth, and fifth grade students recruited from public elementary schools in Lawrence, Kansas. Eligibility criteria for participation included 1) the child being enrolled in these grades, 2) the student speaking and reading English, and 3) the child's parent or custodial caregiver providing informed consent for participation. All students meeting these criteria were deemed eligible regardless of weight status, sex, or ethnicity. The methods described above were approved by the University of Kansas Institutional Review Board (HSCL# STUDY00000035).

Procedures.

All procedures were approved by the school district and each elementary school principal in the district was given the opportunity to have the school participate in the study. Two schools elected to participate. All eligible students within participating schools were solicited for participation in the study. Participants were recruited through consent forms sent home with the students, as well as contact with research staff at parent-attended school events. Children's assent for participation was verbally assessed and recorded by research personnel at each data collection occasion.

Data were collected twice per year (i.e., October and April) during the school day. Data collection days and times were determined by the school principal to achieve minimal disruption to school activities. Children completed questionnaires with the assistance of a research staff member who read the measures out loud to small groups of children. Children were also given ActiGraphs to wear for a week. They were told to wear the devices at all times, except while bathing and swimming. An incentive for participation in the study consisted of a visit from the author's university mascot if more than 70% of children return consent forms from a given school (consent forms may indicate approval or disapproval for participation in the study and still count towards incentive). Both schools earned the incentive. Gift cards in the amount of $5 were given to students upon return of their ActiGraph.

Measures

Demographics. Demographic characteristics including sex, age, grade, race/ethnicity, and weight status were collected. The child was asked to identify a best friend. A "best friend" was operationalized as peer with whom the child spent time and who was valued above other peers.

Physical Activity. Physical activity was measured objectively at both data collection time points using ActiGraphs (Model GT3X, ActiGraph, LLC). ActiGraphs are small devices with electronic motion sensors designed to capture continuous data on quantity and intensity of physical activity. The ActiGraph has been validated for measurement among both child and adolescent populations against indirect calorimetry (Melanson & Freedson, 1995) and observational techniques (Fairweather, Reilly, Grant, Whittaker, & Paton, 1999) and shown to be accurate. The ActiGraph was set to capture data over a 30 second epoch interval. Consistent with product recommendations, participants were instructed to wear the ActiGraph on their non-dominant hip. Children were instructed to wear the device for at least five consecutive days. A participant's data were included in analyses if four or more monitoring days were valid, which is consistent with previous research showing that four days provides reliable estimates of physical activity engagement in children (Davison, Werder, Trost, Baker, & Birch, 2007; Trost, McIver, & Pate, 2005). The indicators for the physical activity engagement latent construct was the total minutes per day of moderate-to-vigorous physical activity (MVPA) for four days.

Athletic Competence. The Harter Self-Perception Profile for Children is a measure of perceived competence in specific domains and overall self-worth, developed for use with children in third through sixth grades (Harter, 2012). The athletic competence domain refers to one's ability to do well at sports, confidence in trying new sports, and willingness to play sports rather than exercise. Harter (2012) reported internal reliabilities between 0.76 and 0.91 for the subscales and indicated the validity of administration of the individual subscales independent of the full scale. In this study, children were asked to report on their own athletic competence as well as their perceptions of their best friend's athletic competence. The child was asked to name his/her best friend in the same grade at the Time 1 data collection and to report on his/her perceptions of the best friend's athletic competence, using the same items as in the typically administered Harter. During the Time 2 data collection, the child was asked to report on the same best friend identified at Time 1. While this adaptation of the measure is novel, it is consistent with Harter's adaptation of the child measure to create a teacher version. The teacher version of the Harter allows teachers and other adults to respond to a subset of the same items to which the child is responding in order to obtain a measure of how the adult perceives the child's competence (Harter, 2012). This methodology is also consistent with the procedures utilized by other studies examining perceptions of peers (Prinstein, Meade, & Cohen, 2003).

Analyses

A multi-step method was used to test the hypothesized relationships among constructs. Structural equation modeling (SEM) techniques in Mplus was used to conduct all data analyses. SEM offers some advantages over traditional regression analyses, including the ability to utilize latent variables and the advantage of being able to estimate and analyze the entire model simultaneously (Little, 2013). First, the overall measurement model was evaluated to confirm the factor structure of the latent variables. Model fit was evaluated based on several fit statistics. Because the chi-square statistic is highly sensitive to sample size, fit statistics of the RMSEA, CFI, and NNFI/TLI were used to evaluate model fit for the measurement model and invariance testing. According to interpretation guidelines suggested by Little (2013), the RMSEA was considered poor fit if the value was > .10, mediocre fit if the value fell between .10-.08, acceptable fit if the value fell between .08-.05, good/close fit if it fell between .05-.02, and great fit if the value was <.01. Similarly, Little (2013) suggests that CFI values and TLI/NNFI below .85 represent poor fit, values .85-.90 represent mediocre fit, values .90-.99 represent acceptable fit, values .95-.99 represent very good fit, and values < .99 represent outstanding fit. Next, for longitudinal models, invariance testing was conducted to assess whether the latent constructs were invariant across the two time points. According to traditional procedures, models constraining factor loadings, intercepts, and the variances/covariances between the two time points were tested to determine if a significant change in model fit resulted, which would suggest that the measures are not invariant across time points.

Lastly, the proposed dyadic relationships were examined. The dyadic influence of best friendship on physical activity behaviors was examined using dyadic analyses based upon the Actor-Partner Interdependence Model (APIM) developed by Kenny (1996) and used in a similar study (e.g., Lopes, et al., 2013). The APIM analyzes the mutual influence between two individuals and is based on the premise that individuals can be linked, such that one person's score provides information about the other person's score (Cook & Kenny, 2005). The current study analyzed models specified to test the latent regressive pathways between dyads and within a child over time. To compare the size of two parameters (e.g., is the effect of the child athletic competence on child physical activity significantly different from the effect of perceived best friend athletic competence on child physical activity), the CFI goodness-of-fit value for the model was compared when the parameters were forced to be equal versus when they are allowed to be vary independently (Cook & Kenny, 2005).

Data missingness was handled with Full Information Maximum Likelihood (FIML) to allow for use of all data within the dataset (Enders, 2006). Data missing due to the fact that a best friend was not participating in the study (thereby precluding collection of the best friend's self-report and physical activity data) were considered "missing at random." Children with this type of missing data were included in the study and their data handled with FIML techniques.

A power analysis was conducted to determine the number of participants needed to provide enough power to detect significant effects in the proposed models. The Monte Carlo approach was used to determine power and sample size. The Monte Carlo approach is preferred when conducting analyses in SEM, as it determines power based simulated analyses in SEM based on anticipated relationships between constructs (Muthen & Muthen, 2002). The power analysis was run based on anticipated relationships in the first model tested. Previous research was used to determine that anticipated correlations were set at 0.3 and loadings were set at 0.65 (e.g., Davison et al., 2007; Jago et al., 2011; Lopes et al., 2013; Pfeiffer et al., 2009; Stein et al., 2007; Welk et al., 2003). Due to the anticipated enrollment of 70% of eligible students, missing data for the best friend physical activity variable were set at 30%. In accordance with the amount of missing data in a similar study of elementary students (Jensen, Cushing, & Elledge, 2014), the amount of missing data for other variables were set at 8%. Procedures were followed in accordance with Muthen and Muthen (2002). Findings indicated that sufficient power would be achieved to detect anticipated relationships in Aim 2 (models with most complex longitudinal constructs) with a sample size of 130.

The APIM framework was used to guide analyses. This structure conceptualizes the interdependence between best friends by proposing that an individual's behavior within a dyad is influenced by the individual's own attitudes or behavior (i.e., actor effects; "a" in Figure 3) as well as the friend's attitudes or behaviors (i.e., partner effects; "p" in Figure 3). As depicted in Figure 3, each member of the dyad had a score both on the causal variable (i.e., Time 1 variables; denoted as X and X^I) and a score on the outcome variable (i.e., Time 2 variables; denoted as Y and Y^I). The horizontal effect describes the change over time due to correlations with self-characteristics, and the crossed effects describe changes over time due to influences from peer characteristics.

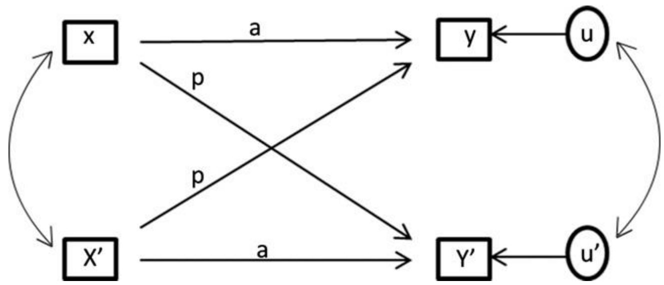

Figure 3. From Lopes et al., 2013. The Actor-Partner Interdependence Model. Horizontal lines represent self-influences (actor effects) and crossed-effects represent influences from the peer (partner effects).

SEM procedures were adapted to estimate the parameters described by the actor and partner effects (Kenny, Kashy, & Cook, 2006). The data were analyzed in dyadic units, with the child and best friend considered a single unit. The data in this analysis were analyzed as distinguishable units, meaning that each unit of the analysis forms a distinct category. In this case, because the child is reporting on *perceptions* of the best friend, the child and the best friend become distinct entities within the models. Furthermore, due to the likelihood of a significant number of non-reciprocal friendships over time, Little and Card (2005) recommend conceptualizing the dyads as distinguishable pairs.

To examine the first hypothesis, the model depicted in Figure 4 was examined. This model tested the relationship between the child and best friend's physical activity at Time 1 as predictors of their physical activity at Time 2, with gender as covariates. To examine the second hypothesis (Figure 5), the child's athletic competence at Time 1 and the child's report of perceptions of the best friend's athletic competence were examined as predictors of the child's athletic competence at Time 2 and the perceptions of the best friend's athletic competence at Time 2. The degree to which the change in the child's athletic competence is influenced by perceptions of the best friend was examined. Child and best friend gender were included as covariates. The third hypothesis is depicted in Figure 6. The child's athletic competence and perceived best friend athletic competence were examined in relation to the child and the best friend's physical activity engagement cross-sectionally, with gender included as a covariate.

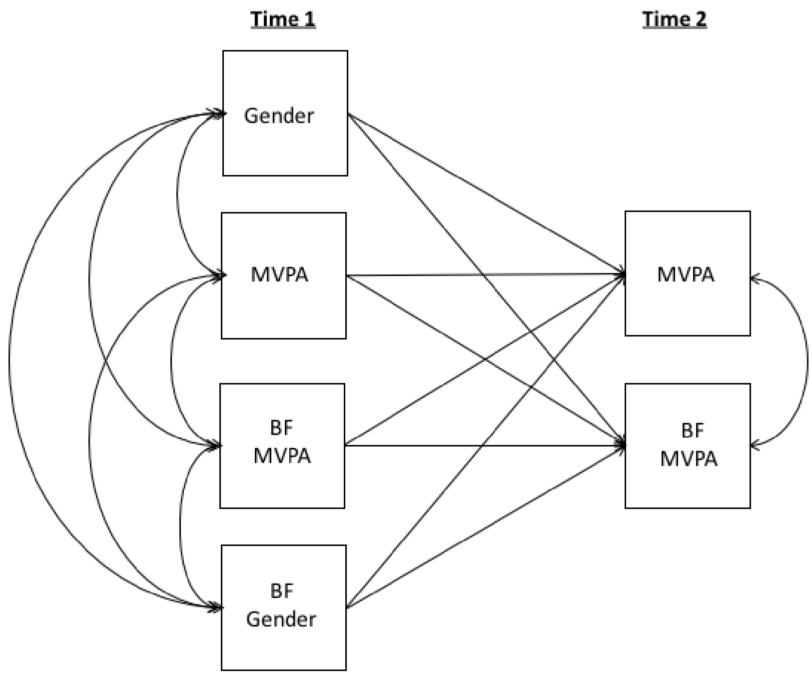

Figure 4. Proposed model of the child and BF MVPA at Time 1 predicting the same variables at Time 2.

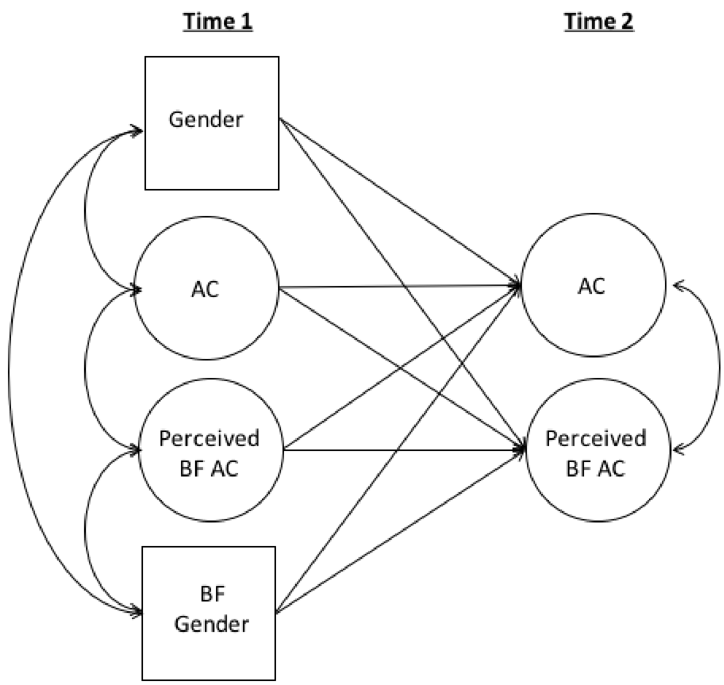

Figure 5. Proposed model of child AC and perceived BF AC at Time 1 predicting the same variables at Time 2.

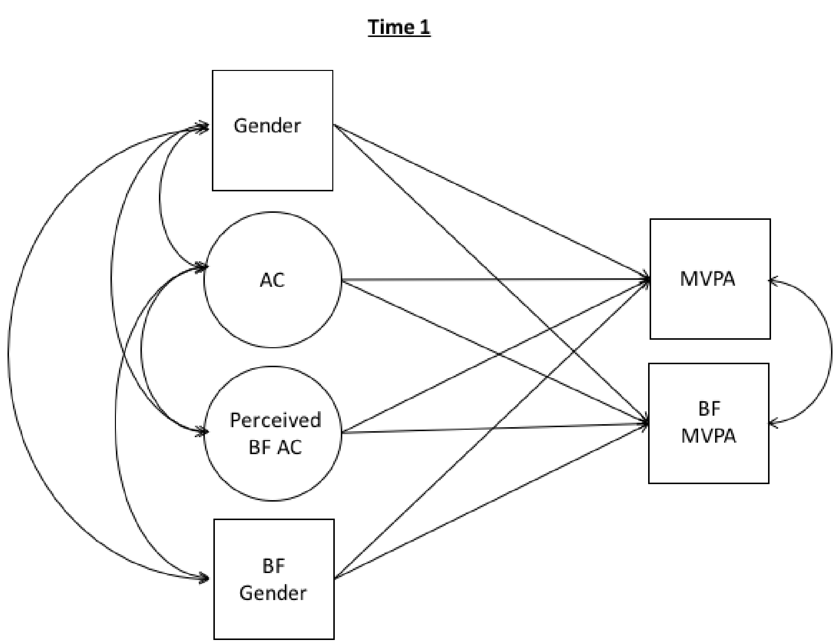

Figure 6. Proposed model of child AC and perceived BF AC at Time 1 predicting MVPA of the child and best friend at Time 1.

Results

Table 1 provides an overview of the sample. At Time 1, 292 students were enrolled in the 3rd, 4th, and 5th grades of the two schools. Recruitment efforts in resulted in 240 (82.2%) students returning parental consent forms. Of these, 187 (78%) forms granted parental permission to participate in the study; 53 (22%) denied parental permission. Of the 187 potential participants for whom parental permission was granted, 132 (71%) completed data collection at Time 1. Of those (n = 55) that did not compete data collection at Time 1, 15 changed schools between consent and data collection, five parents withdrew consent, five children refused to participate (i.e., did not assent), 30 were absent on the day of data collection. Of the 132 participants with complete data at Time 1, ten were lost to follow up at Time 2, resulting in a final sample size of 122 participants with complete data across both assessments.

Participants were relatively evenly split across grades, although fewer third graders participated than fourth and fifth graders. Data provided by the school district suggested that 38% of students in these grades qualify for free or reduced lunch. A little under half of the participants (41.7%) were female. Of the 132 participants, 118 students identified a best friend, and 85 of these best friends were participants in the study. Sixteen of these friendships (13.5%) were reciprocal, meaning that each party indicated the other as the best friend. The percentage of the current sample demonstrating reciprocal friendships is significantly less than that of 35.9% documented by Jago et al. (2011) with 10-11 year olds. Table 2 displays baseline and Time 2 levels of main constructs. Across all variables, there were no significant changes over time. Children on average engaged in 154 minutes of moderate-to-vigorous physical activity over four days, which equates to about 38.5 minutes per day. There was a trend towards best friend BMI being lower than child BMI, but this was non-significant (p = 0.05). A correlation matrix of study variables is presented in Table 3.

Table 1

Demographic Variables at Baseline

Demographic Variable	N
Time 1 participants (N)	132
Time 2 participants (N)	122
% Female	41.7
Grade (N)	
3rd grade	29
4th grade	41
5th grade	48
Age [M (SD)]	9.35 (0.89)
Best friends (N)	118
Best friends also in study (N)	85
Reciprocal dyads (N)	16
Ethnicity	
Caucasian	62.9%

Hispanic	4.5%
American Indian	2.3%
African-American	6.8%
Asian	3.8%
Other	16.7%

Table 2

Mean Scores on Measures

Variable	Time 1 Mean (SD)	Time 2 Mean (SD)	Significant Difference?
AC	3.07 (0.53)	3.05 (0.69)	ns
Perceived BF AC	3.15 (0.53)	3.16 (0.58)	ns
BF AC	3.02 (0.47)	3.13 (0.58)	ns
MVPA (minutes/day for 4 days)	154.39 (76.50)	149.92 (98.46)	ns
BF MVPA (minutes/day for 4 days)	167.25 (71.28)	150.52 (100.83)	ns
BMIz	0.11 (1.10)	0.07 (1.11)	ns
BF BMIz	-0.24 (0.98)	-0.15 (1.02)	ns

Table 3

Correlation Coefficients of Variables

Variables	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
1. AC	-	-	-	-	-	-	-	-	-	-	-
2. T2 AC	0.93* (0.07)	-	-	-	-	-	-	-	-	-	-
3. Perceived BF AC	0.52* (0.12)	0.31* (0.11)	-	-	-	-	-	-	-	-	-
4. T2 Perceived BF AC	0.30* (0.12)	0.36* (0.11)	0.74* (0.07)	-	-	-	-	-	-	-	-
5. BF AC	0.28 (.16)	0.34* (0.13)	0.66* (0.12)	0.57* (0.14)	-	-	-	-	-	-	-
6. T2 BF AC	0.11 (.17)	0.08* (0.14)	0.42* (0.15)	0.32* (0.17)	-0.91* (0.10)	-	-	-	-	-	-

7. MVPA	0.25*	0.21*	0.24*	0.22*	0.25*	0.26*	-	-	-	-	-
	(0.09)	(0.10)	(0.11)	(0.10)	(0.14)	(0.13)					
8. T2 MVPA	0.19*	0.25	0.13	0.10	0.00	-0.02	0.49*	-	-	-	-
	(0.09)	(0.10)	(0.11)	(0.10)	(0.14)	(0.13)	(0.08)				
9. BF MVPA	0.06	0.06	-0.03	0.10	0.23	0.09	0.51*	0.19	-	-	-
	(0.13)	(0.14)	(0.15)	(0.15)	(0.16)	(0.16)	(0.09)	(0.14)			
10. T2 BF MVPA	0.20*	0.06	0.35*	0.31*	0.23	0.08	0.30*	0.09	0.51*	-	-
	(0.12)	(0.14)	(0.13)	(0.14)	(0.16)	(0.15)	(0.11)	(0.13)	(0.10)		
11. Gender	0.37*	0.25*	0.23*	0.21*	0.20	0.08	0.34*	0.32*	0.39*	0.45*	-
	(0.10)	(0.10)	(0.10)	(0.10)	(0.13)	(0.13)	(0.09)	(0.08)	(0.10)	(0.09)	
12. BF Gender	0.24*	0.08	0.18	0.10	0.30*	0.17	0.22*	0.17	0.32*	0.42*	0.95*
	(0.11)	(0.10)	(0.10)	(0.10)	(0.12)	(0.13)	(0.09)	(0.09)	(0.11)	(0.09)	(0.10)

Values presented as standardized correlation estimate (standard error)

*p < .05

To examine the first hypothesis, that child and BF MVPA at Time 1 would be associated with their MVPA at Time 2, a model was tested examining MVPA over time (Figure 7). Model fit statistics were excellent (RMSEA = 0.00, 95% CI = 0.00, 0.00; CFI = 1.00; TLI = 1.00; chi square test of model fit = 63.93, df = 15, $p < 0.01$). As this model was solely made up of indicators (i.e., no latent variables due to physical activity being a single item indicator), invariance testing was not applicable. Results indicated that consistent with hypotheses, MVPA and BF MVPA were associated significantly at Time 1 (i.e., significant cross-sectional partner effects). Contrary to expectations, this similarity did not increase over time; in contrast, no association was detected between variables at Time 2. Longitudinal actor effects were supported and longitudinal partner effects were partially supported (i.e., Time 1 MVPA was significantly related to Time 2 BF MVPA).

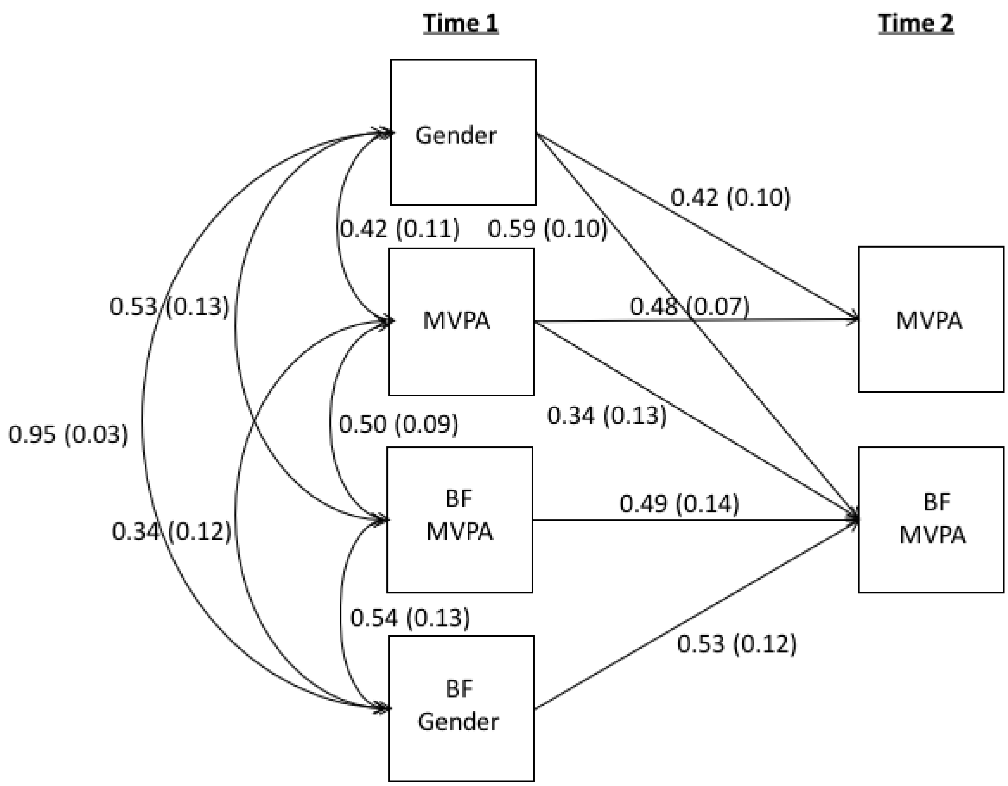

Figure 7. Longitudinal relationships between child and BF MVPA. Lines represent pathways statistically significant at $p < .05$. Values represent standardized regression estimates with standard errors.

To examine the next hypothesis, that AC would be associated with the target child's perception of the best friend's AC and that the target child will adapt his/her AC over time in order to become closer to the perceived BF AC, a model was evaluated to examine the relationships between AC and perceived BF AC at Time 1 and Time 2 (Figure 8). The fit statistics were acceptable, with the RMSEA yielding good fit (RMSEA = 0.04, 95% CI = 0.02, 0.05), the CFI yielding acceptable fit (CFI = 0.92), and the TLI acceptable (TLI = 0.90). The chi square was 326.63, df = 268, p = 0.01. When loading invariance was tested, there was no significant change in model fit statistics (i.e., < 0.01 change in CFI), indicating that loadings are consistent across the two time points. Due to the model passing the loading invariance test, further intercept invariance testing was then conducted, and the CFI did not change significantly, indicating that invariance over time was tenable.

In support of this hypothesis, AC and perceived BF AC were significantly related to each other cross-sectionally at both time points (i.e., significant cross-sectional partner effects) and each were significantly related to the Time 2 version of themselves (i.e., significant longitudinal actor effects). When the relationship between AC at Time 1 and Time 2 were constrained to be equal to the relationship between perceived BF AC at Time 1 and perceived BF AC at Time 2, no significant change in model fit resulted. This result indicates that these two pathways are not significantly different from one another. Contrary to expectations, longitudinal partner effects (e.g., relationship between Time 1 AC and Time 2 perceived BF AC) were not significant. Also, the hypothesis that the Time 2 relationship between AC and perceived BF AC would be stronger than the Time 1 relationship between these variables was also not supported, as no significant difference in model fit was found when these correlations were constrained to be equal.

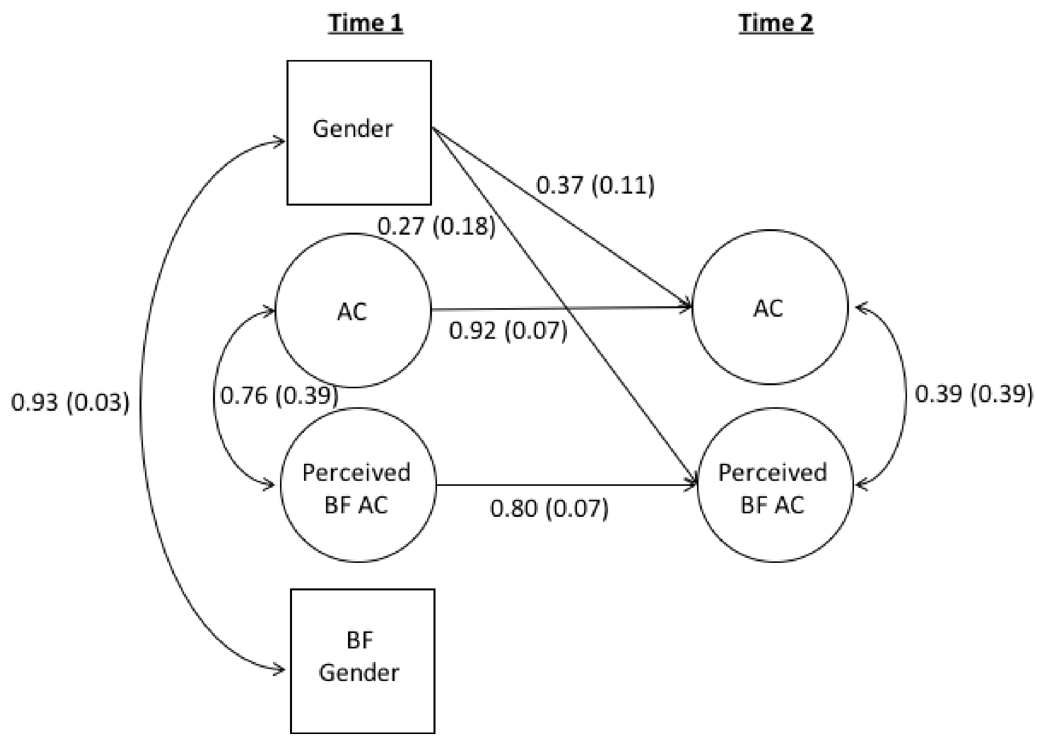

Figure 8. Longitudinal relationships between AC and perceived BF AC. Lines represent pathways statistically significant at $p < .05$. Values represent standardized regression estimates with standard errors.

To further examine the relationships between child and best friend AC, a second model evaluated the longitudinal relationship between AC and self-reported BF AC, accounting for gender (Figure 9). The fit statistics were very good, with the RMSEA yielding good fit (RMSEA = 0.03, 95% CI = 0.00, 0.04), the CFI yielding very good fit (CFI = 0.96) and the TLI also very good fit (TLI = 0.95). The chi square was 299.66, df = 274, p = 0.14. When loading invariance was tested, there was no significant change in model fit statistics (i.e., <0.01 change in CFI), indicating that loadings are consistent across the two time points. Because the model passed loading invariance testing, further intercept invariance testing was then conducted, and the CFI did not change significantly. Consistent with expectations, longitudinal actor effects were significant for both AC and BF AC. However, unlike the previous model (Figure 7), cross-sectional partner effects were only significant at Time 1. Furthermore, longitudinal partner effects were partially supported, in that BF AC at Time 1 was significantly associated with AC at Time 2.

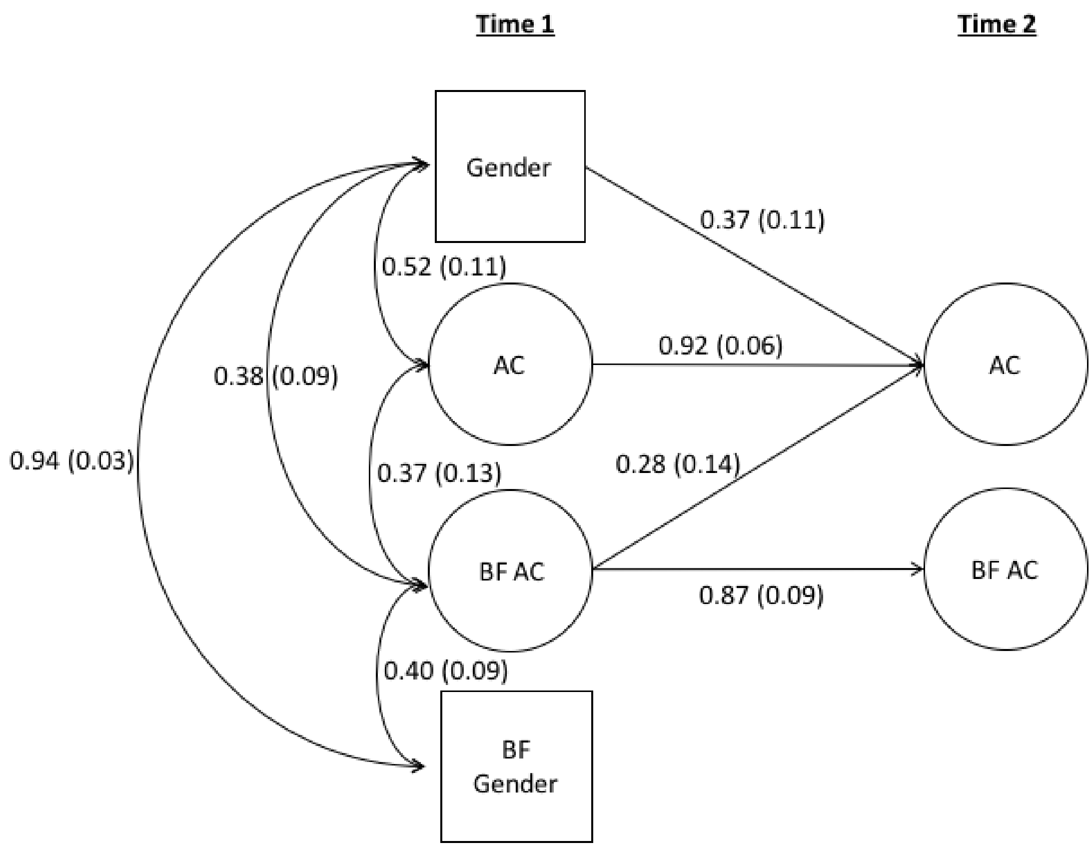

Figure 9. Longitudinal relationships between AC and BF AC. Lines represent pathways statistically significant at $p < .05$. Values represent standardized regression estimates with standard errors.

To examine last hypothesis, that AC and perceived BF AC would be associated with the child's engagement in MVPA cross-sectionally, a model was analyzed to examined relationships at Time 1 between AC, perceived BF AC, MVPA, and BF MVPA (Figure 10). The fit statistics were in acceptable ranges (RMSEA = 0.06, 95% CI = 0.04, 0.08; CFI = 0.90; TLI = 0.86; chi square test of model fit = 134.97, df = 87, $p < 0.01$). Because variables were measured at Time 1 only, invariance testing was not conducted. In support of the hypothesis, AC and perceived BF AC were correlated with MVPA, and AC was also associated with BF MVPA. Contrary to expectations, perceived BF AC was not significantly related to BF MVPA.

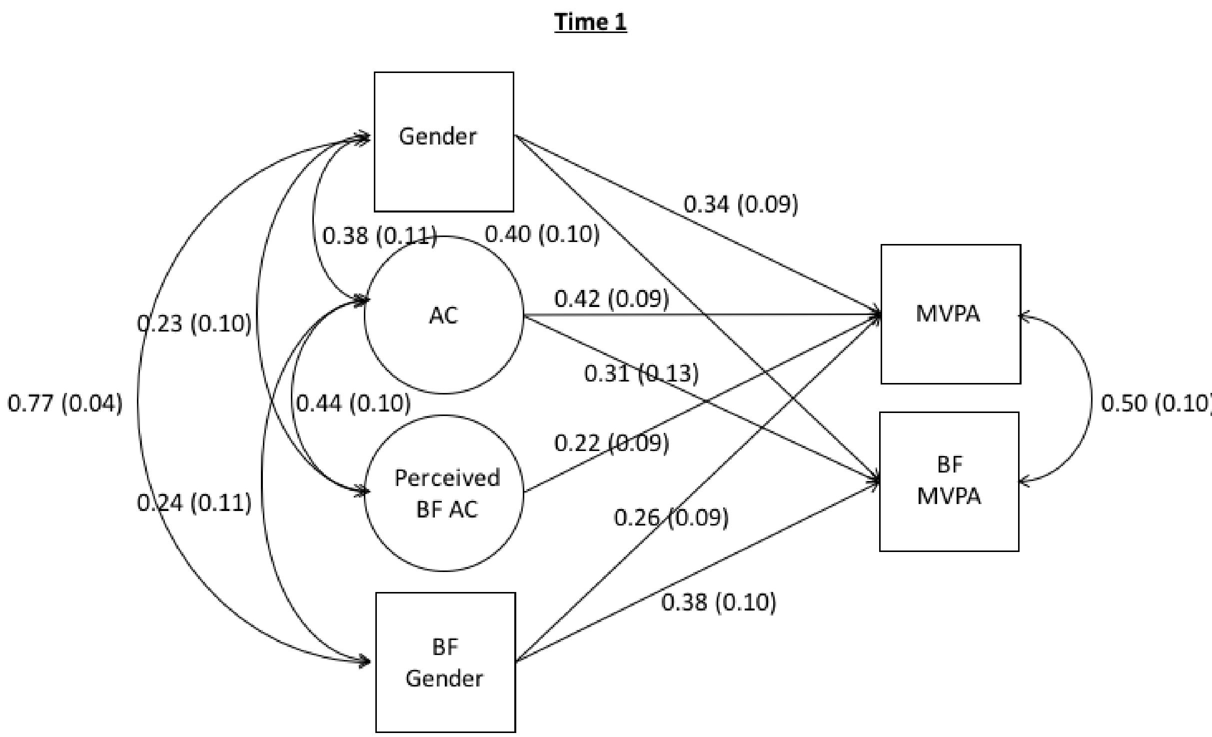

Figure 10. Cross-sectional relationships between AC, perceived BF AC, and MVPA. Lines represent pathways statistically significant at $p < .05$. Values represent standardized regression estimates with standard errors.

A second model was evaluated to further examine the relationships between AC and MVPA, and to better understand the influences on perceived BF AC. This model builds upon the previous model (Figure 10), and examines the relationship between BF AC, child AC, and MVPA (Figure 11). The fit statistics were in mediocre to acceptable range (RMSEA = 0.05, 95% CI = 0.03, 0.06; CFI = 0.89; TLI = 0.86; chi square test of model fit = 246.32, df = 186, $p \leq$

0.001). Because all variables were measured at Time 1, invariance testing was not conducted. Building off the previous model, these results suggested that perceived BF AC is associated with both actual BF AC and with the child's own AC. Unlike perceived BF AC, BF AC was significantly related to BF MVPA. All three types of AC significantly related to child MVPA.

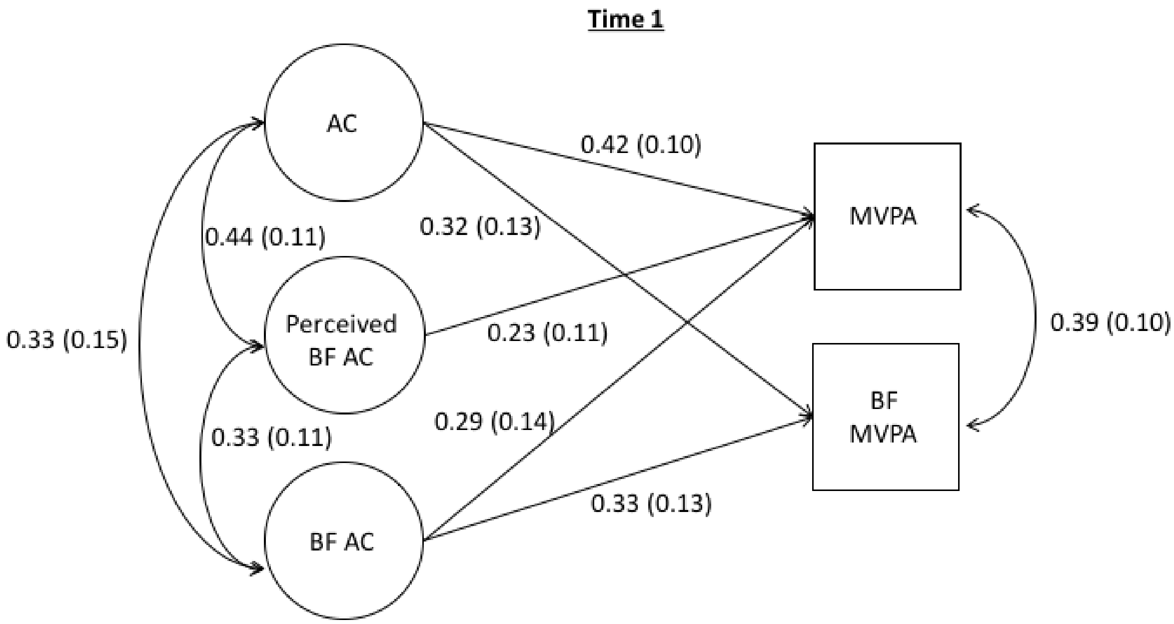

Figure 11. Cross-sectional relationships between AC, perceived BF AC, BF AC, and MVPA. Lines represent pathways statistically significant at p < .05. Values represent standardized regression estimates with standard errors. Due to concerns about readability, gender is not represented in the depicted model, although it was included in the analyses.

Discussion

School-aged children engage in more physical activity with peers than when alone, both in experimental settings (Barkley et al., 2014) and naturalistically (Pearce, Page, Griffin, & Cooper, 2014). However, peers can also be impediments to physical activity through avenues such as teasing about weight and athletic ability (e.g., Faith et al., 2002). Despite these strong associations and the importance of physical activity promotion for obesity prevention, less research has been conducted on the long term role peers play in shaping childhood physical activity habits and internal beliefs about athletic competence (AC). Theories of motivated behavior (e.g., social cognitive theory; Bandura, 1986) posit that AC is a precursor to engagement in physical activity, and the literature has shown these two constructs to be highly correlated (e.g., Welk & Schaben, 2004). However, AC is also associated with other important constructs such as enjoyment of physical activity (Cairney et al., 2012), loneliness and sociometric status (Dunn, Dunn, & Bayduza, 2007), depressive symptoms (Kim-Spoon, Ollendick, & Seligman, 2012), as well as scholastic ability and global self-esteem (Muldoon, 2000).

The most comprehensive studies previously available on the long term role of peers in shaping physical activity are three studies of peer networks; two studies measured adolescent peer groups over one school year (de la Haye et al., 2011; Simpkins et al., 2012) and the third study measured school-aged children over 12 weeks in an after school program (Gesell et al., 2012). These studies all found that groups of friends demonstrated similar levels of activity, became more similar over time, and were influenced by each another's physical activity. However, a lack of literature exists on the role of dyadic relationships in shaping physical activity, despite evidence that best friends play an important and unique role in a child's social development (e.g., Bowker et al., 2006; McChristian, Ray, Tidwell, & LoBello, 2012). In light of these factors, a primary aim of the current study was to expand the literature on peer influence on physical activity by examining whether best friend pairs, instead of friend groups, also demonstrated these same patterns of social influence on physical activity. Because there is reason to suspect that athletic competence (AC) and physical activity would follow similar patterns due to their consistently high correlations in the literature (e.g., Welk & Schaben, 2004), the present study also expands the literature by examining the degree to which AC, best friend AC (BF AC), and perceived best friend AC (perceived BF AC) also followed these same patterns of peer relationship (i.e., cross sectional similarity, increase in similarity, and longitudinal influence).

Physical Activity

With regard to the first hypothesis, that target children and best friends would demonstrate similar levels of moderate-to-vigorous physical activity (MVPA) cross-sectionally and increase in similarity of MVPA over time, results provided partial support (Figure 7). Child and BF MVPA were associated at Time 1, but not at Time 2. Thus, the prediction that this similarity would increase over time was not supported. Furthermore, longitudinal partner effects (i.e., one child's influence over time on the other child) were partially supported. The child's MVPA at Time 1 significantly predicted BF MVPA at Time 2. However, the reverse relationship (i.e., BF MVPA at Time 1 predicting child MVPA at Time 2) was not supported. The evidence found here for similarity between friends at Time 1 is similar to previous findings of cross-sectional similarity between best friends' physical activity (Jago et al., 2011; Lopes et al., 2013). However, the lack of continued similarity at Time 2 and the partial support for longitudinal influence were inconsistent with the previous longitudinal studies that have found support for increased similarity and influence over time among a group of peers (i.e., de la Haye et al., 2011; Gesell et al., 2012; Simpkins et al., 2012).

The lack of evidence for increased similarity and peer influence over time in the current study was unexpected given the strong evidence for these processes in peer groups (de la Haye et al., 2011; Gesell et al., 2012; Simpkins et al., 2012). However, the current study differs from these previous studies in several aspects, which may account for discrepant findings. Simpkins et al. (2012) and de la Haye et al. (2011) both examined adolescents over one year using three self-reported items of physical activity. Limitations and potential biases present in self-report measures of physical activity have been well documented (e.g., Sallis & Saelens, 2000). Furthermore, these three items were not part of a validated measure, increasing the potential for bias and lack of construct validity. The current study assessed MVPA using an objective technique (i.e., actigraphy) that has been extensively validated (Melanson & Freedson, 1995; Fairweather et al., 1999). Therefore, the conclusions drawn in the current study about peer influences on physical activity may be more accurate than those drawn in Simpkins et al. (2012) and de la Haye et al. (2011). Specifically, the current results are robust to self-report bias. Possibly, the same factors that are thought to contribute to this bias in self-reported measures of MVPA (e.g., social desirability; Klesges et al., 2004), also contribute to the finding that children perceive themselves to be like peers in terms of physical activity. Future studies are encouraged to use a well-validated (preferably objective) measure of physical activity.

A third longitudinal study examining peer influence on physical activity (Gesell et al., 2012) was more similar to the current study in terms of using objectively-measured physical activity and a sample of school-aged children. However, the timeframe of measurement was substantially different between Gesell et al. (2012) and the current study. Specifically, Gesell et al. used a 12-week window of measurement, divided into two six-week increments. Their findings indicated that children changed their physical activity behavior in response to peers during the first six weeks only. Perhaps the timing of measurement is critical in order to detect associations between friends. The finding that friendship influence was only detected in a six-week window (but not in the current study) suggests that the current study's window of one school year (i.e., October to April) may have been too wide to detect this relationship.

Although the current study hypothesized that best friendship influence on study variables would extent over the academic year, it may be that friendship "turnover" during the school year attenuated the relationships between best friend pairs' MVPA at Time 2. Indeed, Cairns, Leung, Buchanan, and Cairns (1995) found that when fourth grade children were asked to list their friends at two time points just three weeks apart, the lengths of the lists changed significantly and the chances of a mutual friendship occurring at both time points was low. A study of school-aged children over an academic year found that best friendships persisted between fall and spring for about 50% of the sample (McChristian, Ray, Tidwell, & LoBello, 2012), a pattern also recorded with early adolescent best friendships over the same timeframe (Bowker, 2004). The current study did not assess the strength of friendship over the academic year; thus, the degree to which strength of friendship over time moderated the associations between friends' MVPA over time cannot be established. However, one possible indication of strength of friendship is friendship reciprocity between friendship pairs; in the current study, rates of reciprocity were relatively low compared to Jago et al. (2011). Given the mixed literature in this area (e.g., Gesell et al., 2012) and the different lengths of time employed across studies, future investigations of MVPA across friendship dyads should measure strength and/or quality of friendship longitudinally as a means of capturing this additional source of variance.

Athletic Competence

Robust literatures on health risk behavior and deviance have demonstrated that perceptions of friends' behaviors exert significant influence on target children's own behavior (e.g., La Greca et al., 2001; Prinstein et al., 2003; Sneed, Tan, & Meyer, 2015; Wentzel, Baker,

& Russell, 2012). Yet, perceptions of friends have not been examined in the context of physical activity. This study represents the first time that perceived BF AC was examined for its longitudinal associations with child AC and MVPA. Findings indicated that the hypothesized associations between child AC and perceived BF AC were supported at both Time 1 and Time 2 (Figure 8). Children perceived that their AC was similar to their best friend's AC at both the beginning and end of the school year. This finding demonstrated that the same pattern of cross-sectional similarity between children and best friends that has been previously documented for physical activity (de la Haye et al., 2011; Gesell et al., 2012; Simpkins et al., 2012) and BF AC (Sabiston & Crocker, 2008) is also present with perceived BF AC. Furthermore, this finding indicated that children perceive they have similar levels of AC as their best friends, in the absence of actual similarity (as evidenced by the lack of association between AC and BF AC at Time 2).

However, the hypothesized increase in the similarity between AC and perceived BF AC over time was not supported by the current analyses, as the relationship between the two variables did not increase from Time 1 to Time 2. Furthermore, the longitudinal partner-effect relationships between AC and perceived BF AC were also not supported. These findings demonstrated that the child is similar to current perceptions of the best friend, but perceived BF AC does not directly predict future child AC. This lack of increased similarity and peer influence again is inconsistent with previous studies which found evidence for peer influence for physical activity in peer groups (i.e., de la Haye et al., 2011; Gesell et al., 2012; Simpkins et al., 2012).

To further examine the relationship between child and best friend AC, the relationship of target child AC was examined in association with actual BF AC. It was predicted that child AC and BF AC would be similar at both Time 1 and Time 2. This hypothesis was partially supported, with friends displaying similar AC at Time 1, but not at Time 2 (Figure 9). Thus the similarity at Time 1, but not Time 2, was consistent with Sabiston and Crocker's (2008) finding of cross-sectional similarity between child and friends' AC. Furthermore, the lack of a relationship between child and BF AC at Time 2 indicated that the hypothesized increase in similarity across time was not supported. However, a significant partner-effect longitudinal pathway was detected between BF AC at Time 1 and child AC at Time 2. This finding indicated that BF AC directly predicted future child AC. Interestingly, this longitudinal influence occurred despite the fact that the child and the BF AC were no longer associated at Time 2. These findings were largely inconsistent with the longitudinal patterns between friends' physical activity documented in the literature (i.e., de la Haye et al., 2011; Gesell et al., 2012; Simpkins et al., 2012).

Finally, the relationships between child and BF AC, perceived BF AC, and child and BF MVPA were examined to determine the degree to which perceived BF AC was distinct from actual BF AC and was related to MVPA (Figure 11). Findings indicated that perceived BF AC was significantly and uniquely related to both child AC and child MVPA, even in a model that also included BF AC. Perceived BF AC was thus shown to not be redundant with actual BF AC. These findings are consistent with the broader literature describing the strong relationship between AC and physical activity (e.g., Vedul-Kjelsase et al., 2011), and with the literature on perceptions of peers demonstrating unique associations with child behavior (La Greca et al., 2001; Prinstein et al., 2003; Sneed, Tan, & Meyer, 2015; Wentzel, Baker, & Russell, 2012).

Overall, these findings uniformly indicated that children and their best friends were similar at Time 1 across AC and MVPA variables. This conclusion is consistent with hypotheses, and with the cross-sectional literature suggesting that children are similar to their best friends' physical activity (Jago et al., 2011; Lopes et al., 2013) and peer networks' AC (Sabiston & Crocker, 2008). However, this similarity largely did not persist at Time 2. Consequently, the hypotheses that friends would become more alike over the year was not substantiated in the current study. At Time 2, children only displayed similarity to perceived BF AC, but not actual BF AC or BF MVPA. This decrease in similarity at Time 2 is unexpected, given the similarity between friends across variables several months prior, the increase in spent time with friends over middle childhood (Lam, McHale, & Crouter, 2014), and the many potential mechanisms of influence within social groups (e.g., social facilitation, modeling, impression management, group norms, social support; Craft, Pfeiffer, & Pivarnik, 2003; Maturo & Cunningham, 2013; Vedul-Kjelsas, Sigmundsson, Stensdotter, & Haga, 2011). Furthermore, the hypotheses that friends would influence one another over time (i.e., that longitudinal partner effects would be significant) were only substantiated for the influence of BF AC on later child AC, but were not evident for MVPA or perceived BF AC.

As alluded to above, the differences between the present findings and those reported previously in the literature (e.g., de la Haye et al., 2011; Gesell et al., 2012; Simpkins et al., 2012), may be attributed to key differences in study design. In addition to differences in measurement of MVPA and timeframe of the studies, previous studies in the literature also differed from the current study in their sampling of adolescents, instead of children, and level of analysis. Potentially, different social processes are at work in adolescent friendships than child friendships. These differences bear particularly on questions around perceived AC, and the influence of peer AC on MVPA. While social skills develop along a continuum throughout childhood, there is reason to suspect that adolescent friendships may look qualitatively different than child friendships. Adolescents spend a greater quantity of time with peers than do younger children (Bagwell, Schmidt, & Jenchura, 2011) and social cognition-associated brain regions develop significantly during the adolescent years (Mills, Lalonde, Clasen, Giedd, & Blakemore, 2014). As a result, adolescents become more competent at interpersonal skills and develop more intimate friendships than do children (Buhrmester, 1990). These factors may result in the mechanisms of social influence for physical activity (e.g., modeling, social facilitation, teasing) functioning differently between adolescents and children. To examine the possibility of discrepant results being due to differences in age of sample (i.e., adolescent versus school-aged), future studies should be designed to sample a wide age range so they are able to examine age as a moderator of the relationship between the child and peer physical activity and AC.

Differences in study findings may also be attributed to the level of analysis (i.e., dyad versus peer group). Previous studies in this literature (i.e., de la Haye et al., 2011; Gesell et al., 2012; Simpkins et al., 2012) have utilized social network data analysis, which analyzes entire groups of peers. This design is in contrast to the current study, which asked children to identify a single best friend. It is possible that influence between best friend dyads differs from the processes of influence in a group. For instance, a child may not share the same high level of closeness with the entire peer group, as is shared with the best friend. However, relationships with the peer group may be more buffered against friendship fluidity (i.e., even if two individuals lose closeness, the rest of the group may stay intact). It is also possible that the mechanisms of influence (e.g., modeling, social facilitation) function differently within groups compared to dyads. For these reasons, it is possible that influence was detected in the social network studies, but not the current study, due to special characteristics of friend groups that make them uniquely able to shape peer physical activity. In order to examine this possibility, future studies are encouraged to have children identify both a best friend and a group of friends, in order to examine differences in influences among dyads and networks.

Overall conclusions to be drawn from discrepancies in results between the current study and de la Haye et al. (2011), Gesell et al. (2012), and Simpkins et al. (2012) are difficult due to the many confounding study differences. However, the use of self-reported physical activity in two of the studies (i.e., de la Haye et al., 2011; Simpkins et al., 2012), leaves open the possibility that their results would have been different if a validated self-report or objective measure of MVPA had been used. However, Gesell et al.'s (2012) findings are given more credibility as a comparison to the current study due to their use of objectively-measured physical activity and the same age group as the current study. Thus, taken together, the evidence currently supports peer *groups* as better predictors of child physical activity in school-aged children, relative to peer *dyads*. Future studies are encouraged to directly compare the relative contributions of peer groups versus dyads on child physical activity and AC.

A final noteworthy finding of this study was that perceived BF AC was a unique and important contributor to the child's self-schema around physical activity. Child AC persisted in its relationship with perceived BF AC longitudinally. Perceived BF AC also demonstrated a direct association with child MVPA. This pattern of youths' perceptions of peer norms being important, perhaps more so than actual peer norms, has been observed across the child psychology literature. For example, Meldrum and Boman (2013) reported that friends have been shown to overestimate delinquent behavior of peers. Interestingly, this mis-perceived friend delinquency was more closely related to the individual's delinquency than actual peer delinquency (Meldrum & Boman, 2013; Young & Weerman, 2013). Similar findings about the importance of perceived peer norms have been documented for weight status in adolescents

(Perkins, Perkins, & Craig, 2015) and alcohol consumption, drug use, and sexual behavior among college students (Martens et al., 2006). Future studies aiming to understand peer influences on child health behaviors, including physical activity, are encouraged to include measures of perceptions of peers.

Taken together, these findings have important implications for the development and implementation of interventions to increase physical activity in children. Notably, many obesity and physical activity interventions are delivered in group format (e.g., Kalavainen, Korppi, & Nuutinen, 2007), highlighting the importance of understanding social influences on physical activity, AC, and other weight-related variables. The broader literature, along with the current findings, suggest that peer groups, rather than isolated best friendships, may be best suited to promoting social influence on physical activity. In this way, group interventions are potentially well suited to developing positive peer influence. Findings from this study also suggest that the child's physical activity engagement may be influenced by perceptions of the group norm, above and beyond actual peer norms. Consequently, interventions which seek to foster physical activity in a group setting are encouraged to actively create an environment that promotes positive peer interactions and perceptions of group mastery around physical activity. These perceptions may be best achieved when the physical activity environment is structured, as evidenced by Hatfield et al.'s (2015) finding that even children with low AC demonstrated high levels of physical activity when participating in a structured exercise program.

The ability to further understanding the mechanisms of peer influence and translate these findings into effective interventions necessitates increased clarity about moderators and direction of influence between peers on AC and MVPA. For example, the current literature cannot predict whether the friends become more like one friend or the other, an average of the two, or if they move together in a new direction. With the ability to predict direction of change, the translation of these findings to individual children becomes more clear. Interventionists could then better select and promote the peer relationships that are most likely to lead to increased physical activity.

Limitations of this study include a lack of statistical independence due to including largely non-reciprocal best friendships and thus individuals included more than once in the study (i.e., as both a target child and as a best friend), which is a consistent limitation when examining social groups (e.g., de la Haye et al., 2011; Gesell el al., 2012; Jago et al., 2011; Lopes et al., 2013; Simpkins et al., 2012). However, due to the relatively low number of reciprocal best friendships in the sample, limiting participation to just those children with reciprocal best friends would not have allowed for fully powered analyses, nor would it have lead to an accurate representation of the population. The lower percentage of reciprocal best friendships in the current study as compared to Jago et al. (2011) suggests that the current sample differed from this previous work around friendship variables. Future work is encouraged to examine differences in health promotion and peer influence between reciprocal dyads and non-reciprocal dyads. Another limitation of the current study is that children were constricted to having the same best friend at Time 2 as they had identified at Time 1. While this constriction was necessary to examine longitudinal relationships, change in the dynamics of friendship from Time 1 to Time 2 was not captured. As noted above, future studies in this area should capture the variance represented in the strength of friendship dyads as a potential source of moderation on the associations among AC, BF AC, and MVPA.

Despite the limitations noted above, the current study highlights similarity and longitudinal influence between peers in terms of MVPA and AC, using better measures of

MVPA than have been used in the majority of past studies. The current findings provide evidence for the importance of perceived BF AC in terms of its similarity with child AC longitudinally. As a consequence, the current study suggests that mechanisms of influence between peers likely include perceptions of normative behavior. However, there is still a need in the literature to disentangle the influence of friendship networks versus single best friends on child MVPA and AC. In light of these findings, future work should evaluate the strength of best friendship as a moderator of longitudinal associations between MVPA and AC variables over time, directly compare friendship networks to single best friendships as a predictor of future physical activity engagement, and examine whether dyadic influences can be detected over shorter (i.e., six week) increments.

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