Self-perceptions and physical activity in children with and without motor problems

Johannes J. Noordstar

Cover image	Trueffelpix | Fotolia.com
Layout	Renate Siebes | Proefschrift.nu
Printed by	Print Service Ede
ISBN	978-90-393-6653-0

Self-perceptions and physical activity in children with and without motor problems

Zelfbeeld en fysieke activiteit in kinderen met en zonder motorische problemen

(met een samenvatting in het Nederlands)

PROEFSCHRIFT

ter verkrijging van de graad van doctor aan de
Universiteit Utrecht op gezag van de rector magnificus,
prof.dr. G.J. van der Zwaan, ingevolge het besluit van het
college voor promoties in het openbaar te verdedigen
op vrijdag 6 januari 2017 des middags te 2.30 uur

door

Johannes Jacobus Noordstar

geboren op 8 augustus 1981
te Wageningen

Promotor: Prof.dr. M.J. Jongmans
Prof.dr. P.J.M. Helders

Copromotor: Dr. J. van der Net

Dit proefschrift werd financieel ondersteund door de Faculteit Gezondheidszorg van de Hogeschool Utrecht (HU), het Vormingsfonds Oefentherapie Cesar, Stichting Steunfonds Faculteit Gezondheidszorg Hogeschool Utrecht en het Platform Kinderoefentherapie.

Contents

Chapter 1

General introduction

Clinical scenario

A small, timid boy steps into my practice. He introduces himself as Sem and is 8 years of age. He looks kind of pale and reading his body language I am thinking: "This boy does not look happy". His mother immediately starts to express her concerns about her son's gross motor skills and the little interest that he has had in habitual physical activity in the last couple of months. In fact, the only time he plays outside is in the garden with his two-year-younger brother, never with children his own age. When I ask what kind of activities are done as a family, his mother tells me that they usually go outside, but they have been doing this less in the last couple of months. Moreover, Sem prefers to stay at home to play computer games when they go out as a family.

With the parent's permission, I call the elementary school teacher to get information about Sem's academic performance and his behavior at school. His teacher tells me that Sem does not participate in much physical activity during playtime, while other boys are playing either soccer or catch. Sem wanders around the playground most of the time by himself. In the last couple of months he has shown little interest in physical education as well; he looks scared when he has to perform physical education tasks that are expected for a boy his age.

The first thing I do is an assessment of Sem's spontaneous gross and fine motor behavior during a variety of motor activities. Fine motor activities are performed smoothly and without any problem. However, gross motor activities are more difficult. Basic activities like running, hopping, and jumping are done adequately, but when Sem has to climb the wall he starts to get nervous. He makes one attempt and then says, "I don't want to, I don't like it". I get the same reaction when I want him to make a summersault or jump from a bench. When we play soccer he seems to enjoy it at first, but when I put a little more effort in it (and score three goals in a row), he doesn't want to play anymore. I have to persuade him with three free penalties to get him playing again.

After this first assessment, I administer the Movement Assessment Battery for Children – Second Edition (MABC-2) (Henderson, Sugden, & Barnett, 2007) to measure his motor performance and compare his scores with his age group. He scores a total percentile of 16, which indicates a score in the category "at risk for motor difficulties". Looking at the three component scores independently, the score for "manual dexterity" is in the range of "typical motor performance", while the component scores for "aiming and catching" and "balance" are in the range for being "at risk for motor difficulties".

I am not that concerned about the boy's motor performance, based on my assessments and the results of the MABC-2. His behavior shows signs of low self-esteem. I am more concerned about how he perceives himself in doing motor activities: his so-called 'perceived athletic competence'. Therefore, during the next session with his mother waiting in the hall, I ask Sem a couple of questions to gain insight into his perceived athletic competence. By asking him to indicate the importance of being good at specific motor activities, I can also get an impression about how he values these motor tasks. His perceptions of fine motor activities are positive, but his perceptions of ball and gross motor activities are negative. Task values for all three domains are high, resulting in a discrepancy between task values and perceived competence for both ball and gross motor activities.

I then ask him what he wants me to do for him. The first thing he says is "I want to get better at soccer so I can play with my friends during playtime in school". He also wants to improve climbing and playing all sorts of ball games, especially the ones that are done by the children in school and in his neighborhood.

I agree. The first therapy sessions take place at my practice. We practice a great variety of ball activities. I pay extra attention to Sem's perceived athletic competence by, for example, asking him to write down the number of goals he plans to score beforehand. At the end of the game we count the number of actual points he scored and compare these with the number he wrote down. Most of the times the actual scores are higher. After a couple of weeks I visit his school during playtime. He is delighted to see me. The week before we agreed that I would play soccer with him and his classmates during playtime. By the look on his face I can tell he's a bit nervous. We start off on the same team. After a while I tell him that I am getting tired and would like to watch from the sideline. He looks a bit nervous again, but plays on. When playtime is over I ask him if he enjoyed it. A big smile appears on his face and he answers: "very much so". During the next couple of weeks we continue to practice all kinds of ball activities (and climbing). I visit the school now and then to assist him during playtime or physical education lessons.

When our therapy goals are achieved, Sem is a different person compared with the boy who came into my practice several months ago. He looks happy, shakes my hand firmly, and looks me in the eye when speaking. He has all kinds of ideas for our last therapy session. I administered the MABC-2 again. Test results are higher, meaning a total percentile score of 63, and scores on all three components are in the category "typical motor performance". More importantly, his perceived athletic competence has improved significantly. When I ask him if I can help him in any other way, he answers: "No, I can do it myself, I'm no longer scared".

His mother is happy as well. She is pleased to see that Sem plays outside with children his own age. They took my advice and started to go outdoors more as a family. They like going to the park, the playground, and the forest. Sem also plays with the other children during playtime at school and the school informed me on a follow-up call that he improved in physical education.

The above clinical case shows the necessity for pediatric physical therapists to have a broad perspective on children with motor problems to provide the best possible care. More specifically, pediatric physical therapists need to be aware of the determinants of physical activity behavior in children with motor problems who experience problems in their daily life. These determinants should be taken into account, and preferably altered, during treatment sessions. In this dissertation, we focus specifically on children's self-perceptions and describe the results of our research on the development of, and associations between, self-perceptions and activity behavior in typically developing children and children with motor problems.

Self-perceptions: Theoretical framework

Self-perceptions prominently influence global self-concept (Marsh, 1990; Shavelson, Hubner, & Stanton, 1976; Sonstroem, Harlow, & Josephs, 1994) and intrinsic motivation for achievement behavior (Eccles et al., 1983; Harter, 1981). Historically, self-perceptions were seen as a comprehensive, unidimensional construct (i.e., global self-concept) (e.g., Coopersmith, 1967; Piers, 1969). Global self-concept is defined as a person's overall perception of himself and generally regarded as an important index of well-being and mental health (see for review Harter, 1999). In 1976, Shavelson et al. (1976) argued strongly for a hierarchical and multidimensional ordering of self-perceptions with global self-concept at the apex of the model. They argued that global self-concept was influenced by a number of more domain-specific self-perceptions (e.g., academic self-concept, emotional self-concept, physical self-concept), which, in turn, were influenced by even more specific self-perceptions (e.g., perceived athletic competence, perceived physical appearance) and self-efficacies (Marsh, 1990; Shavelson et al., 1976). However, their review of the literature provided only weak support for their model, mainly because none of the measurements used in the included articles hypothesized lower-order self-perceptions (Shavelson et al., 1976).

From the 1980s onwards, with Herbert W. Marsh and Susan Harter being the pioneers, measurements that acknowledged the hierarchical and multidimensional ordering of self-perceptions were developed, investigated, and found to explain more variance than the unidimensional measurements. Now, it is widely accepted that self-perceptions are multidimensional and hierarchically ordered, with global self-concept at the apex of the self-perception models (Fox & Corbin, 1989; Marsh, 1990; Shavelson et al., 1976; Sonstroem et al., 1994; Sonstroem & Morgan, 1989). Global self-concept is often used interchangeably with global self-esteem, though there are small theoretical differences. Global self-concept is a person's perceptions of himself (Marsh & Shavelson, 1985), while global self-esteem is the evaluation of these perceptions (see Harter, 1999, 2012). Although theoretically differentiated, global self-concept and global self-esteem are, practically and empirically, two sides of the same coin (e.g., Hagborg, 1993; Marsh, 1986). Moreover, it is seemingly impossible to have a global perception about yourself without taking your evaluation of this perception into account. We, therefore, use the term global self-esteem in this dissertation.

Self-concept theorists focus primarily on investigating associations between self-perceptions and global self-esteem while motivational theorists focus primarily on investigating associations between self-perceptions and intrinsic motivation for achievement behavior (Eccles et al., 1983; Harter, 1981; Stodden et al., 2008). Children with high levels of domain-specific self-perceptions are intrinsically motivated to participate in this specific domain, while children with low levels of domain-specific self-perceptions are less motivated (Eccles et al., 1983; Harter, 1981; Stodden et al., 2008). To fully understand intrinsic motivation for achievement behavior, motivational theorists also address the personal importance of being good at the achievement behavior (i.e., task value) (Eccles et al., 1983).

Associations between self-perceptions and corresponding achievement behavior are currently argued to have a reciprocal effect on each other (Marsh, Gerlach, Trautwein, Ludtke, & Brettschneider, 2007; Marsh, Papaioannou, & Theodorakis, 2006; Stodden et al., 2008). This finding has moved the field away from the question of 'which causes which' to the conclusion that self-perceptions and achievement behavior have a causal influence on each other (Wigfield, Eccles, Schiefele, Roeser, & Davis-Kean, 2006).

Where do we stand? (Part I)

Self-perceptions: Associations with global self-esteem and physical activity

Sonstroem, Harlow, and Josephs (1994) addressed the hierarchical and multidimensional structure of global self-esteem in their Exercise and Self-Esteem Model (EXSEM) by focusing on the physical domain (see Figure 1.1). Two levels of self-perceptions influence global self-esteem. The higher, and more global, level is physical self-worth which is influenced by the lower and more specific subdomains: perceived sport competence, perceived physical condition, perceived attractive body, and perceived physical strength (Fox & Corbin, 1989; Sonstroem et al., 1994). These subdomains can be further divided into specific self-efficacies that are associated with the actual physical skills and exercise behavior (e.g., physical activity)

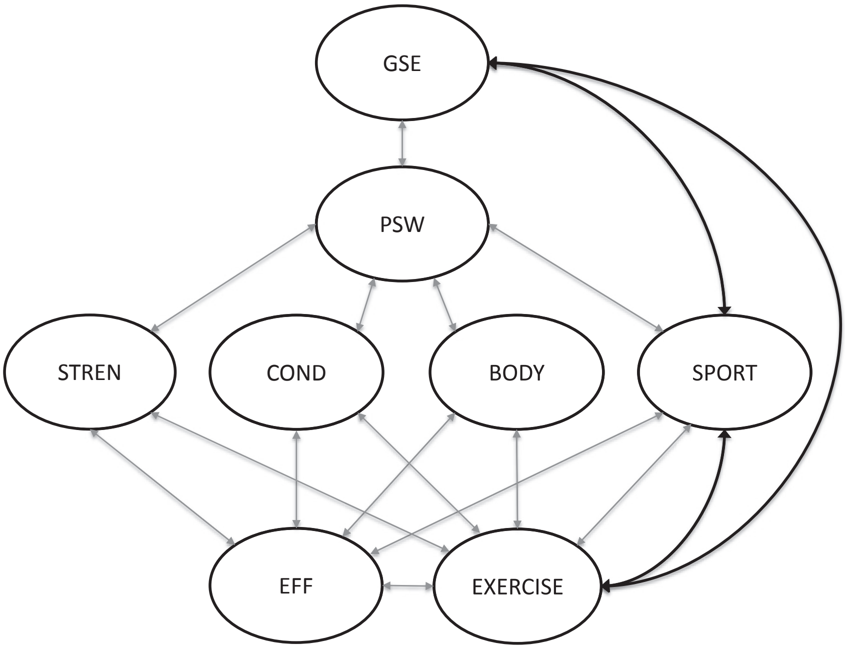


Figure 1.1 The adapted Exercise and Self-Esteem Model (Sonstroem et al., 1994; Sonstroem, 1998). The curved lines represent the associations that we investigated. GSE = global self-esteem; PSW = physical self-worth; SPORT = perceived sport competence; COND = perceived physical condition; BODY = perceived attractive body; STREN = perceived physical strength; EFF = self-efficacies; EXERCISE = exercise behavior.

(Fox & Corbin, 1989; Sonstroem et al., 1994). Various studies found evidence for the mediating effect of physical self-worth and perceived sport competence on the association between physical activity and global self-esteem in adolescents (Beasley & Garn, 2013; Haugen, Safvenborn, & Ommundsen, 2011). An even larger number of studies investigated cross-sectional and longitudinal associations between perceived sport competence (i.e., perceived athletic competence) and physical activity (e.g., Bagoien, Halvari, & Nesheim, 2010; Crocker, Eklund, & Kowalski, 2000; see for review Babic et al., 2014), or between perceived athletic competence and global self-esteem (e.g., Granleese & Joseph, 1994), and found small to moderate associations in older children and adolescents.

Self-perceptions: Developmental changes

Global self-esteem. Global self-esteem is relatively unstable during early childhood (see for review Trzesniewksi, Donnellan, & Robins, 2003). However, these results are based on rank-order stability (i.e., test-retest correlations) instead of investigating growth curves. Investigating growth curves provides insight into within-individual changes, while rank-order stability provides insight into between-individual changes. Subsequently, small changes in global self-esteem will result in a stable global self-esteem when using latent growth curves, while (the same) small changes in global self-esteem might result in an (incorrect) unstable global self-esteem when using rank-order stability. The development of global self-esteem has only been investigated once using latent growth curves in elementary school children (Wigfield & Eccles, 1994). In this study global self-esteem remained stable between grade 1 and grade 6. The authors argue that this stability can be explained by the hierarchical structure of self-perceptions. More specifically, small changes in lower level self-perceptions will not affect the higher-level global self-esteem. Moreover, small changes (i.e., increases) in one lower level of self-perception will cancel out small changes (i.e., decreases) in another lower level of self-perception, resulting in a fairly stable global self-esteem (Marsh, 1990; Shavelson et al., 1976).

Perceived athletic competence. Perceived athletic competence is one of the lower level self-perceptions and more subjected to developmental changes. Perceived athletic competence declines during childhood (Fredricks & Eccles, 2002; Jacobs, Lanza, Osgood, Eccles, & Wigfield, 2002). However, opposite trajectories of developmental change have been found. Wigfield et al. (1997) noted a small but significant decline during elementary school, while Cole et al. (2001) found a small but significant increase. During the transition from elementary school to middle school and during middle school, perceived athletic competence declines rapidly (Fredricks & Eccles, 2002; Jacobs et al., 2002). Although the starting point and speed of decline in perceived athletic competence differs among existing longitudinal studies, all children had an overly optimistic perceived athletic competence at the beginning of elementary school. Younger children do not distinguish between their ideal-self and their actual-self, resulting in overly optimistic self-perceptions (Harter, 1999, 2006, 2012). Furthermore, younger children compare their current performance to their previous performance. Because their performance (ordinarily) increases because of physical maturation, their self-perceptions will also remain overly optimistic. As children grow older, perceived athletic competence declines, resulting in a more realistic self-perception. Marsh and Craven (1997) argue that this decline in perceived competence originates from an increase in performance-based feedback children receive from teachers and parents. In addition, as children's cognitive abilities develop, they become more capable of comparing their performance with their peers instead of with their own previous performance (Harter, 2006).

Physical activity. There is strong evidence that physical activity declines during elementary and middle school (Basterfield et al., 2011; Bradley et al., 2011; Cleland et al., 2010; Lopes, Rodrigues, Maia, & Malina, 2011). In an extensive review of longitudinal studies, sex was the only determinant of the change in physical activity in children between 4 and 9 years of age (i.e., boys are more physically active than girls), while self-efficacy and prior physical activity were the only determinants of the change in physical activity in children and adolescents between 10 and 13 years of age (i.e., higher levels of self-efficacy were associated with more physical activity) (Craggs, Corder, Van Sluijs, & Griffin, 2011).

Self-perceptions: Sex differences

Sex differences in global self-esteem are not yet present during elementary school (Wigfield & Eccles, 1994), but start to appear during middle school specifically in boys (e.g., Morin, Maiano, Marsh, Nagengast, & Janosz, 2013). The primary reason for these differences is the low (domain-specific) self-perceptions of body image in girls, which negatively affects their global self-esteem (see for review Kling, Hyde, Showers, & Buswell, 1999).

Sex differences in perceived athletic competence are already present in the first years of elementary school (Cole et al., 2001; Jacobs et al., 2002; see for review Gentile et al., 2009). Boys have a higher perceived athletic competence than girls in every grade of elementary and middle school. Since the decline in perceived athletic competence is nearly identical for boys and girls, this sex difference is stable over time (Cole et al., 2001; Jacobs et al., 2002). Harter (2006) speculated that, historically, sports have been largely a male domain, and male sport figures would represent more powerful role models than female sport figures, causing sex differences in favor of boys.

Sex differences in physical activity are present in the first years of elementary school, where boys are more physically active than girls. Children become less physically active as they grow older, but this decline is greater in girls than in boys, making girls less physically active in every grade of elementary and middle school (e.g., Basterfield et al., 2011; Cleland et al., 2010).

What we should know, but don't (Part I)

Physical activity is an important component of a healthy lifestyle. Participation in physical activity is preventive against obesity and positively influences mental health (e.g., global self-esteem) (Babiss & Gangwisch, 2009; Biddle & Asare, 2011; Neissaar & Raudsepp, 2011; Tudor-Locke, Craig, Cameron, & Griffiths, 2011). Although the importance of physical activity is widely accepted, children and adolescents are becoming less physically active as they grow older. According to the World Health Organization (2010) recommendations, children and adolescents need moderate-to-vigorous physical activity for at least 60 minutes a day, with strength, flexibility, and coordination exercises to improve or maintain physical fitness at least three times a week (World Health Organization [WHO], 2010). Many children and adolescents in Western society do not meet these recommendations (Aznar et al., 2011; Telford et al., 2013) and, as a result, various studies have investigated the effectiveness of intervention programs to improve physical activity in children and adolescents. Although some researchers are fairly positive, a recently published meta-analysis concluded that intervention programs had a negligible to small effect on improving total physical activity and small to moderate effect on improving moderate-to-vigorous physical activity in children (Metcalf, Henley, & Wilkin, 2012). One possible explanation for this (disappointing) result is that many interventions do not take determinants of physical activity, like perceived athletic competence, into account. A clear understanding of associations between perceived athletic competence and physical activity in children and adolescents is needed to develop more effective intervention programs to improve physical activity.

Babic et al. (2014) performed an extensive systematic review and meta-analysis to investigate associations between perceived athletic competence and physical activity in children and adolescents. They categorized articles based on age (i.e., children, early adolescents, and late adolescents), sex (i.e., boys, girls, mixed samples), and study design (i.e., cross-sectional, longitudinal, and experimental). A total of 59 studies were included. Age was a significant moderator for effects, but sex and study design were not (Babic et al., 2014). Perceived athletic competence was not associated with physical activity in children, but was moderately associated in early and late adolescents. However, the non-significant association between perceived athletic competence and physical activity in children was based on a single study. Furthermore, moderate associations were found in mixed samples, in males only, in females only, in cross-sectional studies, and in longitudinal studies. Associations were strong in experimental studies.

We performed a comparable systematic search to investigate the associations between perceived athletic competence and physical activity in children and adolescents, but focused specifically on longitudinal studies. We included only longitudinal studies because monitoring longitudinal changes sheds light on the stability of the strength and direction of the association between perceived athletic competence and physical activity. Moreover, perceived athletic competence and physical activity are subjected to developmental changes and should therefore be investigated longitudinally in order to understand their association.

We searched the databases SPORTDiscus, PsychInfo, Pubmed, CINAHL, EMBASE and ERIC for studies and found an additional 7 articles (Davison, Downs, & Birch, 2006; Davison, Schmalz, & Downs, 2010; DiLorenzo, Stucky-Ropp, Vander Wal, & Gotham, 1998; Fawkner, Henretty, Knowles, Nevill, & Niven, 2014; Raudsepp, Neissaar, & Kull, 2013; Stein, Fisher, Berkey, & Colditz, 2007; Wagnsson, Lindwall, & Gustafsson, 2014). We argue that two articles that were included in the systematic review and meta-analyses by Babic et al. (2014) should have been excluded because: (a) global self-esteem was investigated instead of perceived athletic competence ($n = 1$) (Schmalz, Deane, Birch, & Krahnstoever Davison, 2007); and (b) perceived competence was operationalized as a barrier for being physically active ($n = 1$) (Niven, Fawkner, Knowles, Henretty, & Stephenson, 2009).

This resulted in a total of 26 articles (indicated with a * in the reference list) that investigated longitudinal associations between perceived athletic competence and physical activity in children and adolescents. Our results were comparable to the results found in the study of Babic et al. (2014), that is, overall, small to moderate associations between perceived athletic competence and physical activity. The only exception was the study by DiLorenzo et al. (1998): the authors found no association between perceived athletic competence (grade 5 and grade 6) and physical activity (grade 8 and grade 9). We argue that this contradictory result is caused by the large (3-year) time interval between assessments.

We focused, in contrast to Babic et al. (2014), specifically on the content of the included articles and found two interesting findings. First, 8 articles reported the association between perceived athletic competence and physical activity in girls only. This special interest in girls is probably because girls, compared with boys, are known to be less physically active (Basterfield et al., 2011; Hearst, Patnode, Sirard, Farbakhsh, & Lytle, 2012) and have lower levels of perceived athletic competence during childhood and adolescence (e.g., Jacobs et al., 2002). We argue that the associations between perceived athletic competence and physical activity should be investigated separately for sex.

Second, only a small number of studies investigated the associations between perceived athletic competence and physical activity in children during elementary school, which was only briefly mentioned by Babic et al. (2014). We argue that, during this period, children develop a variety of motor activities that are necessary to participate in physical activity. Also, the decline in physical activity is already present in children in elementary school. More high-quality longitudinal studies that investigate the associations between perceived athletic competence and physical activity in children in elementary school are therefore needed.

We therefore conducted a longitudinal study to investigate the change in, and associations between, perceived athletic competence, physical activity, and global self-esteem in children in elementary school (**Chapter 2**). In this study, we also investigated the differences in developmental changes and associations between boys and girls.

However, children need more than just a positive evaluation of their own (general) athletic competence to be motivated to participate in activities in daily life. For example, activities like writing or crafts require fine motor skills competence, while activities like basketball and soccer require ball competence as well as athletic competence. Distinguishing between the change in perceived fine motor competence, perceived ball competence, and perceived athletic competence could give us more specific insight into their perceptions of activities in daily life. Motivational theorists argue that task values are important determinants of achievement behavior and are associated with self-perceptions (Eccles et al., 1983). We therefore investigated the development of, and associations between, self-perceptions and task values of fine motor competence, ball competence, and athletic competence in children in elementary school (**Chapter 3**).

Where do we stand? (Part II)

Children with motor problems

A fair number of elementary school children experience difficulties in learning and performing motor skills. If these difficulties give rise to functional problems, children can be diagnosed with Developmental Coordination Disorder (DCD) in which motor performance is substantially below expected levels, given the child's chronological age and previous opportunities for skill acquisition. This disorder interferes significantly with activities in daily life, such as academic achievement and is not due to a general medical condition (American Psychiatric Association [DSM-V], 2013). The most commonly reported prevalence for DCD in school-aged children is about 5–6%, where boys are overrepresented compared to girls by a ratio of 3 to 1 (Blank, Smits-Engelsman, Polatajko, & Wilson, 2012). If all criteria for DCD are described, but one or more of the criteria is not evaluated, children are categorized as having probable DCD (pDCD) (Smits-Engelsman, Schoemaker, Delabastita, Hoskens, & Geuze, 2015).

Children with DCD participate less in physical activities than typically developing children (Baerg et al., 2011; Cairney et al., 2005; Cairney, Hay, Veldhuizen, Missiuna, & Faught, 2010) and have lower levels of perceived athletic competence (Cocks, Barton, & Donelly, 2009; Piek, Dworcan, Barrett, & Coleman, 2000; Poulsen, Ziviani, & Cuskelly, 2006, 2008; Skinner & Piek, 2001). Children with DCD aged 5–6 years still perceive themselves equal to typically developing children (Pless, Carlsson, Sundelin, & Persson, 2001), but at the age of 7 years differences in perceived athletic competence start to appear (Piek et al., 2000; Poulsen et al., 2006, 2008; Skinner & Piek, 2001). Differences in perceived athletic competence between children with DCD and typically developing children increase when they grow older (Piek, Baynam, & Barrett, 2006). Cairney et al. (2005) argued that the differences in physical activity between children with pDCD and typically developing children are mainly due to the difference in perceived athletic competence. They found that perceived athletic competence mediated the effect of pDCD status (yes/no) on physical activity. Stodden et al. (2008) proposed a conceptual model in which perceived motor competence mediates the relationship between motor competence and physical activity, where the associations between motor competence, perceived motor competence, and physical activity are reciprocal (see Figure 1.2). Various studies found support for these suggested associations in typically developing children and adolescents (e.g., Barnett, Morgan, Van Beurden, Ball, & Lubans, 2011; Barnett, Morgan, Van Beurden, & Beard, 2008).

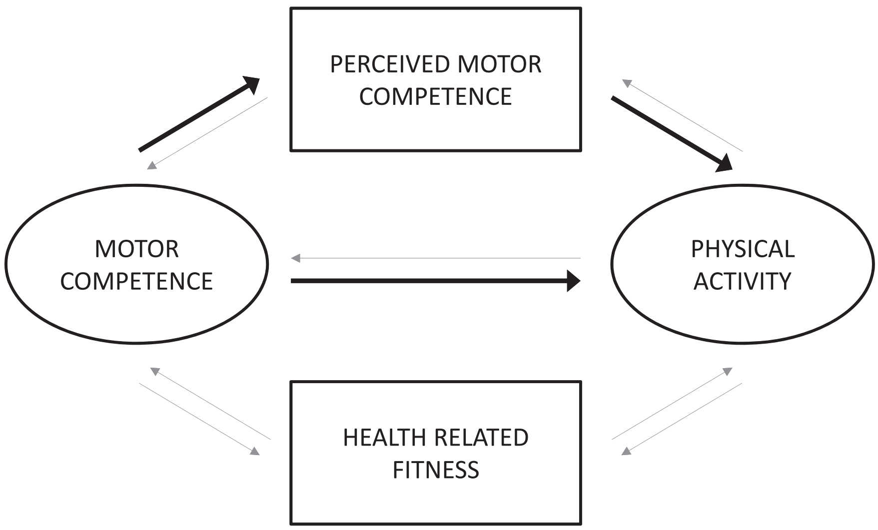


Figure 1.2 The relationship between motor competence and physical activity (adapted from Stodden et al., 2008).
The bold lines represent the paths that we hypothesized for our intervention to enhance physical activity in children with pDCD.

What we should know, but don't (Part II)

Children with pDCD are often referred to a pediatric physical therapist to learn motor activities that are causing problems in their daily life. Learning these motor activities (e.g., riding a bike, rope skipping) is assumed to increase their participation in daily life (e.g., physical activity). No specific attention is paid to increasing the child's perceived athletic competence, though this is argued to (partly) mediate the association between motor performance and physical activity. There is thus a strong argument for using interventions that consist of both a behavioral component (to improve perceived athletic competence) and a motor component (to learn to master new motor activities) to increase children with pDCD's participation in daily life. We therefore investigated the effect of an intervention that consists of a behavioral component (to improve perceived athletic competence) and a motor component (to learn new motor activities) to increase children with pDCD's participation in daily life (**Chapter 4**).

Clinical trials investigate differences in outcome measures between and within participants as a group. However, large intra-group variation can affect the results and hamper clinical decision-making (Horn & Gassaway, 2007; Kersten, Ellis-Hill, McPherson, & Harrington, 2010). We therefore investigated differences in perceived athletic competence and physical activity between children with DCD and typically developing children. Then we investigated the impact of lower levels of perceived athletic competence on physical activity in both groups of children (**Chapter 5**).

Outline and aims of this thesis

- To investigate the change in, and associations between, global self-esteem, perceived athletic competence, and physical activity in typically developing children from kindergarten to grade 4, distinguishing between boys and girls (**Chapter 2**);
- To investigate the change in, and associations between, self-perceptions and task values of fine motor competence, ball competence, and athletic competence in typically developing children from kindergarten to grade 4, distinguishing between boys and girls, and between children with motor problems and typically developing children (**Chapter 3**);
- To investigate the effect of an integrated behavioral and motor intervention in children with pDCD compared with a motor intervention only on motor performance, self-perceptions, and physical activity (**Chapter 4**);
- To investigate differences in perceived athletic competence and physical activity between, and within, children with DCD and control children (**Chapter 5**).

References

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). Washington, DC: American Psychiatric Association

Aznar, S., Naylor, P. J., Silva, P., Perez, M., Angulo, T., Laguna, M., . . . Lopez-Chicharro, J. (2011). Patterns of physical activity in Spanish children: A descriptive pilot study. *Child: Care, Health and Development, 37*, 322-328. doi: 10.1111/j.1365-2214.2010.01175.x

Babic, M. J., Morgan, P. J., Plotnikoff, R. C., Lonsdale, C., White, R. L., & Lubans, D. R. (2014). Physical activity and physical self-concept in youth: Systematic review and meta-analysis. *Sports Medicine, 44*, 1589-1601. doi: 10.1016/j.jsams.2014.11.170

Babiss, L. A., & Gangwisch, J. E. (2009). Sports participation as a protective factor against depression and suicidal ideation in adolescents as mediated by self-esteem and social support. *Journal of Developmental and Behavioral Pediatrics, 30*, 376-384. doi: 10.1097/dbp.0b013e3181b33659

Baerg, S., Cairney, J., Hay, J., Rempel, L., Mahlberg, N., & Faught, B. E. (2011). Evaluating physical activity using accelerometry in children at risk of developmental coordination disorder in the presence of attention deficit hyperactivity disorder. *Research in Developmental Disabilities, 32*, 1343-1350. doi: 10.1016/j.ridd.2011.02.009

Bagoien, T. E., Halvari, H., & Nesheim, H. (2010). Self-determined motivation in physical education and its links to motivation for leisure-time physical activity, physical activity, and well-being in general. *Perceptual and Motor Skills, 111*, 407-432. doi: 10.2466/06.10.11.13.14.pms.111.5.407-432

* Baker, B. L., & Davison, K. K. (2011). I know I can: A longitudinal examination of precursors and outcomes of perceived athletic competence among adolescent girls. *Journal of Physical Activity & Health, 8*, 192-199.

Barnett, L. M., Morgan, P. J., Van Beurden, E., Ball, K., & Lubans, D. R. (2011). A reverse pathway? Actual and perceived skill proficiency and physical activity. *Medicine & Science in Sports & Exercise, 43*, 898-904. doi: 10.1249/mss.0b013e3181fdfadd

* Barnett, L. M., Morgan, P. J., Van Beurden, E., & Beard, J. R. (2008). Perceived sport competence mediates the relationship between childhood motor skill proficiency adolescent physical activity and fitness: A longitudinal assessment. *International Journal of Behavioral Nutrition and Physical Activity, 5*, 1-12. doi: 10.1186/1479-5868-5-40

Basterfield, L., Adamson, A. J., Frary, J. K., Parkinson, K. N., Pearce, M. S., & Reilly, J. J. (2011). Longitudinal study of physical activity and sedentary behavior in children. *Pediatrics, 127*, e24-30. doi: 10.1542/peds.2010-1935

Beasley, E. K., & Garn, A. C. (2013). An investigation of adolescent girls' global self-concept, physical self-concept, identified regulation, and leisure-time physical activity in physical activity. *Journal of Teaching in Physical Education, 32*, 237-252.

Biddle, S. J., & Asare, M. (2011). Physical activity and mental health in children and adolescents: A review of reviews. *British Journal of Sports Medicine, 45*, 886-895. doi: 10.1136/bjsports-2011-090185

Blank, R., Smits-Engelsman, B., Polatajko, H., & Wilson, P. (2012). European Academy for Childhood Disability (EACD): Recommendations on the definition, diagnosis and intervention of developmental coordination disorder (long version). *Developmental Medicine & Child Neurology, 54*, 54-93. doi: 10.111/j.1469-8749.2011.04171.x

Bradley, R. H., McRitchie, S., Houts, R. M., Nader, P., & O'Brien, M.(2011). Parenting and the decline of physical activity from age 9 to 15. *The International Journal of Behavioral Nutrition and Physical Activity, 8*, 33. doi: 10.1186/1479-5868-8-33

Cairney, J., Hay, J. A., Faught, B. E., Wade, T. J., Corna, L., & Flouris, A. (2005). Developmental coordination disorder, generalized self-efficacy toward physical activity, and participation in organized and free play activities. *Journal of Pediatrics, 147*, 515-520. doi: 10.1016/j/jpeds.2005.05.013

Cairney, J., Hay, J. A., Veldhuizen, S., Missiuna, C., & Faught, B. E. (2010). Developmental coordination disorder, sex, and activity deficit over time: A longitudinal analysis of participation trajectories in children with and without coordination difficulties. *Developmental Medicine & Child Neurology, 52*, e67-72. doi: 10.1111/j.1469-8749.2009.03520.x

Cleland, V., Timperio, A., Salmon, J., Hume, C., Baur, L. A., & Crawford, D. (2010). Predictors of time spent outdoors among children: 5-year longitudinal findings. *Journal of Epidemiology & Community Health, 64*, 400-406. doi: 10.1136/jeck.2009.087460

Cocks, N., Barton, B., & Donelly, M. (2009). Self-concept of boys with developmental coordination disorder. *Physical & Occupational Therapy in Pediatrics, 29*, 6-22. doi: 10.1080/01942630802574932

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

Coopersmith, S. (1967). *The antecedents of self-esteem.* San Francisco: Freeman.

Craggs, C., Corder, K., Van Sluijs, E. M., & Griffin, S. J. (2011). Determinants of change in physical activity in children and adolescents: A systematic review. *American Joural of Preventive Medicine, 40*, 645-658. doi: 10.106/j.amepre.2011.02.025

* Crocker, P., Sabiston, C., Forrestor, S., Kowalski, N., Kowalski, K., & McDonough, M. (2003). Predicting change in physical activity, dietary restraint, and physique anxiety in adolescent girls: Examining covariance in physical self-perceptions. *Canadian Journal of Public Health, 94*, 332-337.

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

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

* Davison, K. K., Downs, D. S., & Birch, L. L. (2006). Pathways linking perceived athletic competence and parental support at age 9 years to girls' physical activity at age 11 years. *Research Quarterly for Exercise and Sport, 77*, 23-31. doi: 10.1080/02701367.2006.10599328

* Davison, K. K., Schmalz, D. L., & Downs, D. S. (2010). Hop, skip... no! Explaining adolescent girls' disinclination for physical activity. *Annals of Behavioral Medicine, 39*, 290-302. doi: 10.1007/s12160-010-9180-x

* DiLorenzo, T. M., Stucky-Ropp, R. C., Vander Wal, J. S., & Gotham, H. J. (1998). Determinants of exercise among children. II. A longitudinal analysis. *Preventive Medicine, 27*, 470-477. doi: 10.1006/pmed.1998.0307

Eccles, J. S., Adler, T. F., Futterman, R., Goff, S. B., Kaczala, C. M., Meece, J. L., & Midgley, C. (1983). Expectancies, values, and academic behaviors. In J. T. Spence (Ed.), *Achievement and achievement motivation* (pp. 77-146). San Fransico, CA: W.H. Freeman.

* Fawkner, S., Henretty, J., Knowles, A., Nevill, A., & Niven, A. (2014). The influence of maturation, body size and physical self-perceptions on longitudinal changes in physucal activity in adolescent girls. *Journal of Sports Sciences, 32*, 392-401. doi: 10.1080/02640414.2013.825733

* Findlay, L. C., & Coplan, R. J. (2008). Come out and play: Shyness in childhood and the benefits of organized sport participation. *Canadian Journal of Behavioral Science, 40*, 153-161. doi: 10.1037/0008-400x.40.3.153

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

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

Gentile, B., Grabe, S., Dolan-Pascoe, B., Twenge, J., Wells, B., & Maitino, A. (2009). Gender differences in domain-specific self-esteem: A meta-analysis. *Review of General Psychology, 13*, 34-45. doi: 10.1037/a0013689

Granleese, J., & Joseph, S. (1994). Reliability of the Harter self-perception profile for children and predictors of global self-worth. *The Journal of Genetic Psychology, 155*, 487-492. doi: 10.1080/00221325.1994.9914796

Hagborg, W. J. (1993). The Rosenberg self-esteem scale and Harter's self-perception profile for adolescents: A concurrent validity study. *Psychology in the Schools, 30*, 132-136. doi: 10.1002/1520-6807

Harter, S. (1981). A model of mastery motivation in children: Individual differences and developmental change. In A. Collins (Eds.), *Minnesota Symposium on Child Psychology* (pp. 215-255). Hillsdale, NJ: Lawrence Erlbaum Associates.

Harter, S. (1999). *The construction of the self: A developmental perspective*. New York: Guildford Press.

Harter, S. (2006). The self. In N. Eisenberg, W. Damon, & R. M. Lerner (Eds.), *Handbook of Child Psychology, 6th Edition, Volume 3: Social, Emotional, and Personality Development* (pp. 505-570). Hoboken, NJ: John Wiley & Sons.

Harter, S. (2012). *The construction of the self: Developmental and sociocultural foundations. Second edition.* New York: Guilford Press.

Haugen, T., Safvenborn, R., & Ommundsen, Y. (2011). Physical activity and global self-worth: The role of physical self-esteem indices and gender. *Mental Health and Physical Activity, 4*, 49-56. doi: 10.1016/j.mhpa.2011.07.001

Hearst, M. O., Patnode, C. D., Sirard, J. R., Farbakhsh, K., & Lytle, L. A. (2012). Multilevel predictors of adolescent physical activity: A longitudinal analysis. *The International Journal of Behavioral Nutrition and Physical Activity, 9*, 8. doi: 10.1186/1479-5868-9-8

Henderson, S. E., Sugden, D. A., & Barnett, A. (2007). *Movement assessment battery for children - second edition [Movement ABC-2]*. London: The Psychological Corporation.

Horn, S. D., & Gassaway, J. (2007). Practice-based evidence study design for comparative effectiveness research. *Medical Care, 45*, S50-57.

* Inchley, J., Kirby, J., & Currie, C. (2011). Longitudinal changes in physical self-perceptions and associations with physical activity during adolescence. *Pediatric Exercise Science, 23*, 237-249.

* Jaakkola, T., & Washington, T. (2013). The relationship between fundamental movement skills and self-reported physical activity during Finnish junior high school. *Physical Education and Sport Pedagogy, 18*, 492-505. doi: 10.1080/17408989.2012.690386

Jacobs, J. E., Lanza, S., Osgood, D. W., Eccles, J. S., & Wigfield, A. (2002). Changes in children's self-competence and values: Gender and domain differences across grades one through twelve. *Child Development, 73*, 509-527. doi: 10.111/1467-8624.00421

Kersten, P., Ellis-Hill, C., McPherson, K. M., & Harrington, R. (2010). Beyond the RCT - understanding the relationship between interventions, individuals and outcome - the example of neurological rehabilitation. *Disability and Rehabilitation, 32*, 1028-1034. doi: 10.3109/09638281003775568

Kling, K. C., Hyde, J. S., Showers, C. J., & Buswell, B. N. (1999). Gender differences in self-esteem: A meta-analysis. *Psychological Bulletin, 125*, 470-500. doi: 10.1037/0033-2909.125.4.470

* Knowles, A. M., Niven, A. G., Fawkner, S. G., & Henretty, J. M. (2009). A longitudinal examination of the influence of maturation on physical self-perceptions and the relationship with physical activity in early adolescent girls. *Journal of Adolescence, 32*, 555-566. doi: 10.1016/j.adolescence.2008.06.001

Lopes, V. P., Rodrigues, L. P., Maia, J. A., & Malina, R. M. (2011). Motor coordination as predictor of physical activity in childhood. *Scandinavian Journal of Medicine & Science in Sports, 21*, 663-669. doi: 10.1111/j.1600-0838.2009.01027.x

* Luszczynska, A., & Abraham, C. (2012). Reciprocal relationships between three aspects of physical self-concept, vigorous physical activity, and lung function: A longitudinal study among late adolescents. *Psychology of Sport and Exercise, 13*, 640-648. doi: 10.1016/j.psychsport.2012.04.003

Marsh, H. W. (1986). Global self-esteem: Its relation to specific facets of self-concept and their importance. *Journal of Personality and Social Psychology, 51*, 1224-1236. doi: 10.1037/0022-3514.51.6.1224

Marsh, H. W. (1990). A mulidimensional, hierarchical model of self-concept: Theoretical and empirical justification. *Educational Psychology Review, 2*, 77-172. doi: 10.1007/bf01322177

Marsh, H. W., Gerlach, E., Trautwein, U., Ludtke, O., & Brettschneider, W. D. (2007). Longitudinal study of preadolescent sport self-concept and performance: Reciprocal effects and causal ordering. *Child Development, 78*, 1640-1656. doi: 10.1111/j.1467-8624.2007.01094.x

* Marsh, H. W., Papaioannou, A., & Theodorakis, Y. (2006). Causal ordering of physical self-concept and exercise behavior: Reciprocal effects model and the influence of physical education teachers. *Health Psychology, 25*, 316-328. doi: 10.1037/0278-6133.25.3.316

Metcalf, B., Henley, W., & Wilkin, T. (2012). Effectiveness of intervention on physical activity of children: Systematic review and meta-analysis of controlled trials with objectively measured outcomes (EarlyBird 54). *BMJ, 345*, e5888. doi: 10.1136/bmj.e5888

* Morgan, C. F., Graser, S. V., & Pangrazi, R. P. (2008). A prospective study of pedometer-determined physical activity and physical self-perceptions in children. *Research Quarterly for Exercise and Sport, 79*, 133-140. doi: 10.1080/02701367.2008.10599476

* Morgan, C. F., McKenzie, T. L., Sallis, J. F., Broyles, S. L., Zive, M. M., & Nader, P. R. (2003). Personal, social, and environmental correlates of physical activity in a bi-ethnic sample of adolescents. *Pediatric Exercise Science, 15*, 288-301.

Morin, A. J., Maiano, C., Marsh, H. W., Nagengast, B., & Janosz, M. (2013). School life and adolescents' self-esteem trajectories. *Child Development, 84*, 1967-1988. doi: 10.1111/cdev.12089

Neissaar, I., & Raudsepp, L. (2011). Changes in physical activity, self-efficacy and depressive symptoms in adolescent girls. *Pediatric Exercise Science, 23*, 331-343.

Niven, A., Fawkner, S., Knowles, A., Henretty, J., & Stephenson, C. (2009). Social physique anxiety and physical activity in early adolescent girls: The influence of maturation and physical activity motives. *Journal of Sports Sciences, 27*, 299-305. doi: 10.1080/02640410802578164

* Papaioannou, A., Bebetsos, E., Theodorakis, Y., Christodoulidis, T., & Kouli, O. (2006). Causal relationships of sport and exercise involvement with goal orientations, perceived competence and intrinsic motivation in physical education: A longitudinal study. *Journal of Sports Sciences, 24*, 367-382. doi: 10.1080/02640410400022060

Piek, J. P., Baynam, G. B., & Barrett, N. C. (2006). The relationship between fine and gross motor ability, self-perceptions and self-worth in children and adolescents. *Human Movement Science, 25*, 65-75. doi: 10.1016/j.humov.2005.10.011

Piek, J. P., Dworcan, M., Barrett, N. C., & Coleman, R. (2000). Determinants of self-worth in children with and without developmental coordination disorder. *International Journal of Disability, Development and Education, 47*, 259-272. doi: 10.1080/713671115

Piers, E. (1969). *Manual for the Piers-Harris children's self-concept scale.* Nashville, TN: Counselor Recordings and Tests.

Pless, M., Carlsson, M., Sundelin, C., & Persson, K. (2001). Pre-school children with developmental co-ordination disorder: Self-perceived competence and group motor skill intervention. *Acta Paediatrica, 90*, 532-538. doi: 10.1111/j.1651-227.2001.tb00794.x

Poulsen, A. A., Ziviani, J. M., & Cuskelly, M. (2006). General self-concept and life satisfaction for boys with differing levels of physical coordination: The role of goal orientations and leisure participation. *Human Movement Science, 25*, 839-860. doi: 10.1016/j.humov.2006.05.003

Poulsen, A. A., Ziviani, J. M., & Cuskelly, M. (2008). Leisure time physical activity energy expenditure in boys with developmental coordination disorder: The role of peer relations self-concept perceptions. *OTJR: Occupation, Participation and Health, 28*, 30-39. doi: 10.3928/15394492-20080101-05

* Raudsepp, L., Neissaar, I., & Kull, M. (2013). A longitudinal assessment of the links between physical activity and physical self-worth in adolescent females. *European Journal of Sport Science, 13*, 716-722. doi: 10.1080/17461391.2013.775349

* Raustorp, A., Archer, T., Svensson, K., Perlinger, T., & Alricsson, M. (2009). Physical self-esteem, a five year follow-up study on Swedish adolescents. *International Journal of Adolescent Medicine and Health, 21*, 497-507. doi: 10.1515/ijamh.2009.21.4.497

* Raustorp, A., Mattsson, E., Svensson, K., & Stahle, A. (2006). Physical activity, body composition and physical self-esteem: A 3-year follow-up study among adolescents in Sweden. *Scandinavian Journal of Medicine & Science in Sports, 16*, 258-266. doi: 10.1111/j1600-0838.2005.00483.x

* Raustorp, A., Stahle, A., Gudasic, H., Kinnunen, A., & Mattsson, E. (2005). Physical activity and self-perception in school children assessed with the Children and Youth-Physical Self-Perception Profile. *Scandinavian Journal of Medicine & Science in Sports, 15*, 126-134. doi: 10.1111/j.1600-0838.2004.406.x

Schmalz, D. L., Deane, G. D., Birch, L. L., & Krahnstoever Davison, K. (2007). A longitudinal assessment of the links between physical activity and self-esteem in early adolescent non-hispanic females. *Journal of Adolescent Health, 41*, 559-565. doi: 10.1016/j.jadohealth.2007.07.001

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

Skinner, R. A., & Piek, J. P. (2001). Psychosocial implications of poor motor coordination in children and adolescents. *Human Movement Science, 20*, 73-94. doi: 10.1016/s0167-9457(01)00029-x

Smits-Engelsman, B., Schoemaker, M., Delabastita, T., Hoskens, J., & Geuze, R. (2015). Diagnostic criteria for DCD: Past and future. *Human Movement Science, 42*, 293-306. doi: 10.1016/j.humov.2015.03.010

Sonstroem, R. J. (1998). Physical self-concept: Assessment and external validity. *Exercise & Sport Sciences Reviews*, *26*, 133-164

Sonstroem, R. J., Harlow, L. L., & Josephs, L. (1994). Exercise and self-esteem: Validity of model expansion and exercise associations. *Journal of Sport and Exercise Psychology, 16*, 29-42.

Sonstroem, R. J., & Morgan, W. P. (1989). Exercise and self-esteem: Rationale and model. *Medicine & Science in Sports & Exercise, 21*, 329-337.

* Stein, C., Fisher, L., Berkey, C., & Colditz, G. (2007). Adolescent physical activity and perceived competence: Does change in activity level impact self-perception? *Journal of Adolescent Health, 40*, 462 e461-468. doi: 10.1016/j.jadohealth.2006.11.147

Stodden, D. F., Goodway, J. D., Langendorfer, S. J., Roberton, M. A., Rudisill, M. E., Garcia, C., & Garcia, L. E. (2008). A developmental perspective on the role of the motor skill competence in physical activity: An emergent relationship. *Quest, 60*, 290-306. doi: 10.1080/00336297.2008.10483582

* Taylor, I. M., Ntoumanis, N., Standage, M., & Spray, C. M. (2010). Motivational predictors of physical education students' effort, exercise intentions, and leisure-time physical activity: A multilevel linear growth analysis. *Journal of Sport & Exercise Psychology, 32*, 99-120.

Telford, R. M., Telford, R. D., Cunningham, R. B., Cochrane, T., Davey, R., & Waddington, G. (2013). Longitudinal patterns of physical activity in children aged 8 to 12 years: The LOOK study. *The International Journal of Behavioral Nutrition and Physical Activity, 10*, 81. 10.1186/1479-5868-10-81

* Trautwein, U., Gerlach, E., & Ludtke, O. (2008). Athletic classmates, physical self-concept, and free-time physical activity: A longitudinal study of frame of reference effects. *Journal of Educational Psychology, 100*, 988-1001. doi: 10.1037/0022-0663.100.4.988

Tudor-Locke, C., Craig, C. L., Cameron, C., & Griffiths, J. M. (2011). Canadian children's and youth's pedometer-determined steps/day, parent-reported TV watching time, and overweight/obesity: The CANPLAY Surveillance Study. *The International Journal of Behavioral Nutrition and Physical Activity, 8*, 66. doi: 10.1186/1479-5868-8-66

* Viira, R. (2011). Adolescents' physical self-perception as related to moderate-to-vigorous physical activity: A one-year longitudinal study. *Acta Kinesiologiae Universitatis Tartuensis, 17*, 199-208. doi: 10.12697/akut.2011.17.17

* Wagnsson, S., Lindwall, M., & Gustafsson, H. (2014). Participation in organized sport and self-esteem across adolescence: The mediating role of perceived sport competence. *Journal of Sport and Exercise Psychology, 36*, 584-594. doi: 10.1123/jsep.2013-0137

Wigfield, A., & Eccles, J. S. (1994). Children's competence beliefs, achievement values, and general self-esteem change across elementary school and middle school. *Journal of Early Adolescence, 14*, 107-138. doi: 10.1177/027243169401400203

Wigfield, A., Eccles, J. S., Schiefele, U., Roeser, R. W., & Davis-Kean, P. (2006). Development of achievement behavior. In W. Damon, R. M. Lerner, & N. Eisenberg (Eds.), *Handbook of Child Psychology* (6th Edition ed., Vol. 3, pp. 933-1002). Hoboken, N.J.: John Wiley & Sons.

PART I

Chapter 2

Global self-esteem, perceived athletic competence, and physical activity in children: A longitudinal cohort study

Johannes J. Noordstar
Janjaap van der Net
Suzanne Jak
Paul J.M. Helders
Marian J. Jongmans

Psychology of Sport and Exercise (2016), 22, 83-90

Acknowledgement of authors' contributions:
J.N, J.V.N., P.H., and M.J designed the study; J.N. gathered the data; J.N. and S.J. performed the data-analysis; J.N. and S.J. wrote the paper; J.V.N, P.H., and M.J. edited the paper.

Abstract

Objectives The Exercise and Self-Esteem Model is used as a theoretical framework to describe associations between global self-esteem and physical activity, mediated by perceived athletic competence. We know little about how these associations develop over time in elementary school children. We examined the change in, and associations between, global self-esteem, perceived athletic competence, and moderate-to-vigorous physical activity (MVPA) in children from kindergarten to grade 4. We also investigated if this change and these associations were different for boys and girls.

Design A prospective longitudinal cohort-sequential design that consisted of two cohorts of children.

Methods Children in cohort I were followed from kindergarten to grade 2, and children in cohort II were followed from grade 2 to grade 4. Global self-esteem and perceived athletic competence were measured with the Self-Perception Profile for Children (SPPC) (n = 292; 148 boys), while MVPA was measured with proxy-reports for physical activity filled in by parents (n = 184; 88 boys).

Results Global self-esteem, perceived athletic competence, and MVPA remained stable. Global self-esteem was the same in boys and girls, while boys reported higher levels of perceived athletic competence and were more physically active than girls. The change in global self-esteem was significantly associated with perceived athletic competence and MVPA in girls, but not in boys.

Conclusion There are few developmental changes in global self-esteem, perceived athletic competence, and MVPA from kindergarten to grade 4. The change in global self-esteem was associated with perceived athletic competence and MVPA in girls, but not in boys.

Introduction

Self-perceptions are important determinants of human behavior. A large body of previous research has demonstrated that self-perceptions are multidimensional and hierarchically ordered (see for review Marsh & Shavelson, 1985). Global self-esteem is found at the apex and is considered to be the overall evaluation of self (e.g., Harter, 2006; Marsh, 1990). Global self-esteem is generally regarded as an important index of well-being and mental health (e.g., Paradise & Kernis, 2002; Rosenberg, Schooler, Schoenback, & Rosenberg, 1995). High global self-esteem has been linked to satisfaction and happiness in later life, while low global self-esteem is associated with depression and anxiety (see for review Harter, 1999).

Global self-esteem is influenced by a number of more domain-specific self-perceptions (e.g., Marsh, 1990; Shavelson, Hubner, & Stanton, 1976) that are more predictive for specific behavior (Marsh & O'Mara, 2008). Sonstroem and Morgan (1994) addressed the hierarchical and multidimensional structure of global self-esteem in their Exercise and Self-Esteem Model (EXSEM) by focusing on the physical domain. In the original EXSEM (Sonstroem & Morgan, 1989), a bottom-up process is described in which mastering physical activities positively influences physical self-efficacy that, in turn, leads to an increase in perceived physical competence. This increase in perceived physical competence subsequently influences global self-esteem through the mediation of physical acceptance (Sonstroem & Morgan, 1989). However, in the expanded EXSEM (Sonstroem, Harlow, & Josephs, 1994) global self-esteem is influenced by two levels of self-perceptions. The higher, and more global, level is physical self-worth which is influenced by the lower and more specific subdomains: perceived sport competence, perceived attractive body, perceived physical strength, and perceived physical condition (Fox & Corbin, 1989). These subdomains can be further divided into specific self-efficacies that are associated with the actual physical skills, the lowest level of the model (Sonstroem et al., 1994).

The development and stability of global self-esteem

The stability of global self-esteem seems relatively low during early childhood (see for review Trzesniewksi, Donnellan, & Robins, 2003). However, the authors based their results on rank-order stability (i.e., test-retest correlations) instead of investigating growth curves. Investigating growth curves provides insight in within-individual changes, while rank-order stability provides insight in between-individual changes. Subsequently, small changes in global self-esteem will result in a stable global self-esteem when using latent growth curves, while (the same) small changes in global self-esteem might result in an (incorrect) unstable global self-esteem when using rank-order stability. To our knowledge, global self-esteem has only been investigated once using latent growth curves in elementary school children (Wigfield and Eccles, 1994). Global self-esteem remained the same between grade 1 and grade 6. The authors argue that this stability is caused by the hierarchical structure of self-perceptions. More specifically, small changes in lower level self-perceptions will not affect the higher-level global self-esteem. Moreover, small changes (i.e., increases) in one lower level self-perception will cancel out small changes (i.e., decreases) in another lower level self-perception, resulting in a fairly stable global self-esteem (Marsh, 1990; Shavelson et al., 1976).

The development and stability of perceived athletic competence

Lower level self-perceptions are more specific and more subjected to developmental changes (Marsh, 1990). One of the lower level self-perceptions is perceived athletic competence, comparable to sport competence as described in the EXSEM. Perceived athletic competence declines during childhood (Cole et al., 2001; Fredricks & Eccles, 2002; Jacobs, Lanza, Osgood, Eccles, & Wigfield, 2002; Wigfield et al., 1997). Wigfield et al. (1997) found this decline to be best described by a negative linear trend during elementary school (grade 1 to grade 6). Although already present during elementary school, this decline in perceived athletic competence accelerates in middle school (grade 7 and grade 8) (Fredricks & Eccles, 2002; Jacobs et al., 2002). However, not all research support the above-described pathway of decline. In the study by Cole et al. (2001) perceived athletic competence increased significantly during elementary school, and only dropped noticeably during the transition from elementary school to middle school (grade 6 to grade 7).

Although the starting point of decline in perceived athletic competence differs among existing longitudinal studies, all children had an overly optimistic perceived competence at the beginning of elementary school (e.g., Fredricks & Eccles, 2002; Jacobs et al., 2002). As children grow older, perceived athletic competence declines resulting in a more realistic self-perception. Marsh and Craven (1997) argue that this decline in perceived competence comes from an increase in performance-based feedback children receive from teachers and parents. In addition, as children's cognitive abilities develop, they become more capable of comparing their performance with their peers instead of with their own previous performance (Harter, 2006).

The development and stability of physical activity

There is extensive evidence that children participate less in moderate-to-vigorous physically activity (MVPA) as they grow older (e.g., Basterfield et al., 2011; Cleland et al., 2010). Moreover, there is a large number of children in Western society that do not meet recommendations for MVPA (Aznar et al., 2011; Telford et al., 2013), while participation in MVPA is an important component of a healthy lifestyle. Also, participation in MVPA is, besides preventive against obesity, essential for social interaction and life satisfaction (e.g., global self-esteem) (Babiss & Gangwisch, 2009; Biddle & Asare, 2011).

Gender differences

Gender differences in global self-esteem are not yet present during elementary school (Wigfield & Eccles, 1994), but small gender differences start to appear during middle school in favor of boys (e.g., Morin, Maiano, Marsh, Nagengast, & Janosz, 2013). Kling, Hyde, Showers, and Buswell (1999) argue that these differences are due to the lower self-perceptions for body image in girls, although only small to moderate differences in body image between boys and girls were found in an extensive meta-analysis (Gentile et al., 2009). Another possible explanation for differences in global self-esteem between boys and girls is the lower perceived athletic competence in girls.

Gender differences in perceived athletic competence are already present in the first years of elementary school. Boys have a higher perceived athletic competence than girls in every grade of elementary and middle school (Cole et al., 2001; Fredricks & Eccles, 2002; Jacobs et al., 2002; Wigfield et al., 1997). Since the decline in perceived athletic competence is nearly identical for boys and girls, this gender difference is stable over time (e.g., Cole et al., 2001; Jacobs et al., 2002). Harter (2006) speculated that, historically, sports have been largely a male domain, and male sport figures would represent more powerful role models than female sport figures, causing gender differences in favor of boys.

Gender differences in MVPA are also present in the first years of elementary school, where boys are more physically active than girls (Basterfield et al., 2011; Cleland et al., 2010). Children become less physically active as they grow older, but this decline is greater in girls than in boys making girls less physically active in every grade of elementary and middle school (Basterfield et al., 2011; Cleland et al., 2010).

With the growing number of children that do not meet recommendations for MVPA investigating associations between global self-esteem, self-perceptions about physical activity (e.g., perceived athletic competence), and MVPA would provide vital information for intervention programs to promote MVPA, and in turn, enhance global self-esteem in children. The elementary school years are of special interest because children develop and consolidate a variety of motor activities that are necessary to participate in MVPA during this period. Furthermore, associations should be investigated longitudinally because constructs are subjected to developmental changes during childhood.

Our first aim was therefore to investigate the change in global self-esteem, perceived athletic competence, and MVPA in children from kindergarten to grade 4. We investigated if this change was different for boys and girls. Our second aim was to investigate longitudinal associations between the change in global self-esteem, perceived athletic competence, and MVPA. Again, we investigated if associations were different for boys and girls.

We hypothesized that global self-esteem would remain stable over time and would be the same in boys and girls. We furthermore hypothesized that perceived athletic competence and MVPA would decline in children from kindergarten to grade 4. We expected boys to have higher scores for perceived athletic competence and to participate more in MVPA than girls in kindergarten. We expected these differences in perceived athletic competence between boys and girls to remain stable and differences in MVPA between boys and girls to become larger over time. Next, we hypothesized positive associations between the change in global self-esteem, perceived athletic competence, and MVPA. However, we expected these associations to be stronger between global self-esteem and perceived athletic competence, and between perceived athletic competence and MVPA, than between global self-esteem and MVPA because of the mediating effect that perceived athletic competence is believed to have. We expected these associations to be of similar magnitude in boys and girls.

Methods

The current study is part of a larger 'Move Along' [Beweeg je mee] longitudinal study, in which we investigate the change in, and associations between, motor performance, perceived competence, task values, global self-esteem, and physical activity in elementary school children. Data were collected once a year between January and June in 2011, 2012, and 2013. The Medical Research Ethics Committee of the University Medical Centre Utrecht approved this study. All families gave written informed consent for their child's participation. All children gave verbal assent as well.

Participants

Children. A total of 307 children participated in this 2-year longitudinal study. Ten children dropped out during the course of the study because of emigration (n = 6), moving to an unknown location (n = 3), or no longer wanting to participate for unknown reasons (n = 1). As we used latent growth curve modeling for our statistical analyses, equal numbers of responses from each participant were not required. Children with missing data were, therefore, not excluded from the analysis but contributed less to the result. Some children (n = 13) had to repeat a grade or were referred to a school for special education (n = 2) during the course of the study. Because we used grade as the time interval to investigate the change in perceived athletic competence and global self-esteem, we decided to exclude these children. Therefore, a total of 292 children (148 boys) divided over two cohorts were included in this study. Cohort I consisted of children in kindergarten (n = 146; 80 boys), while cohort II consisted of children in grade 2 (n = 146; 68 boys) at first assessment. The age of the children in cohort I ranged between 4 and 7 years and in cohort II between 7 and 9 years. Cohort I was composed of 121 Caucasian children and 25 children from non-western ethnic minorities (mainly Northern African children). Cohort II was composed of 119 Caucasian children and 27 children from non-western ethnic minorities (mainly Northern African children).

Parents. Two hundred ninety parents gave informed consent to fill in a 7-day activity diary. One hundred seventy-five activity diaries were returned at first assessment, 133 at second assessment, and 119 at third assessment. We excluded activity diaries where less than 50 percent was filled in (n = 10). A total of 184 parents completed activity diaries on at least one occasion (from cohort I: 94 parents; 52 boys; age range 4 to 6 years; n = 84 Caucasian children, n = 10 children from non-western ethnic minorities, from cohort II: 90 parents; 36 boys; age range 7 to 9 years; n = 84 Caucasian children, n = 6 children from non-western ethnic minorities) (see Table 2.1).

Measures

The current study used the Dutch version of the Self-Perception Profile for Children (SPPC) (Veerman, Straathof, Treffers, Van den Bergh, & Ten Brink, 1997) to investigate perceived athletic competence and global self-esteem and a 7-day activity diary to investigate MVPA. Other measures used in the "Move Along" [Beweeg Je Mee] study, but not reported in this article, are the How Am I doing questionnaire (Calame et al., 2009), a pedometer (Yamax CW700 DigiWalker), the Movement Assessment Battery for Children – Second Edition

Table 2.1 Characteristics of the children

Characteristics of the children	Total sample of children $n = 292$	Subset of children $n = 184$	
Gender % (*n*)			
Boys	51 (148)	48 (88)	
Girls	49 (144)	52 (96)	
Ethnicity % (*n*)			
Caucasian	82 (240)	91 (168)	
Non-Western ethnic minorities	18 (52)	9 (16)	
Cohorts % (*n*)			
Cohort I	50 (146)	51 (94)	
Cohort II	50 (146)	49 (90)	
Mean physical activity (*SD*)		Boys	Girls
Kindergarten		.33 (.10)	.28 (.10)
Grade 1		.34 (.14)	.27 (.12)
Grade 2		.36 (.12)	.31 (.10)
Grade 3		.35 (.16)	.33 (.13)
Grade 4		.37 (.14)	.29 (.14)

Note. Subset of children = children whose parents had completed activity diaries; KG = kindergarten.

(MABC-2) (Henderson, Sugden, & Barnett, 2007), and the subscale "active recreational activities" of the Family Environmental Scale (FES) (Moos & Moos, 1994).

Perceived athletic competence and global self-esteem. The Dutch version of the Self-Perception Profile for Children (SPPC) (Veerman et al., 1997) consists of 36 questions divided over six subscales. In this study we used the subscales *perceived athletic competence* and *global self-esteem*. Each question consists of two contradictory quotes. The child has to choose which quote describes him/her best. For example: 'some kids are really good at sports' or 'other kids are not so good at sports'. After choosing one of the quotes, the child has to indicate whether this was either 'a little bit true for me' or 'totally true for me'. The total score per subscale ranges between 6 and 24 points. Higher scores indicate a more positive perception for athletic competence and global self-esteem. The scales were developed for children between 8 and 12 years and have good validity and reliability (Muris, Meesters, & Fijen, 2003). However, the majority of children in cohort I of our study was younger than 8 years. We therefore investigated factor loadings of the questions on the subscale athletic competence and global self-esteem for the model that fitted the data best and found acceptable to high factor loadings indicating a valid measurement of perceived athletic competence and global self-esteem (see Supplementary Table S2.2).

Moderate-to-Vigorous Physical Activity. Parents were asked to report their child's activities after school and on weekends daily for 7 consecutive days. The activity diary consists of 30-minute time blocks between 15:00 and 19:00 on Monday, Tuesday, Thursday, and Friday, between 12:30 and 19:00 on Wednesday[1], and between 08.00 and 19.00 on Saturday and Sunday. Every time block was scored based on Bouchard's method (Bouchard et al., 1983) to assess the energy expenditure of the activity. Scores range between 1 and 9, with higher scores indicating higher energy expenditure. Next, we categorized every time block as *MVPA* or *no physical activity*. Activities with a score of 6 (e.g., leisure activities outside) or higher were considered as *MVPA*, while scores below 6 were considered as *no physical activity*. We then summed up the number of time blocks that were categorized as *MVPA*. We divided the number of time blocks that were categorized as *MVPA* by the number of time blocks that were filled in. By doing so, we calculated the percentage of time that children participated in MVPA after school and on weekends. Proxy reports for physical activity appeared to be adequate and suitable (Manios, Kafatos, & Markakis, 1998). After the first author scored all activity diaries two graduate students checked the scores of 118 activity diaries (28% of total) for errors. There was initial disagreement between the first author and the two graduate students in less than 1 percent of the cases. In addition, two other graduate students together scored 50 activity diaries (12% of total) to investigate inter-rater reliability with the first author. Inter-rater reliability between the first author and the two students was high ($r = .914$; $p < .001$).

Procedure

Thirteen elementary schools in a central province of the Netherlands (Utrecht) participated in the "Move Along" [Beweeg Je Mee] study. After receiving approval from the principals of the primary schools, the parents of all children in kindergarten and grade 2 received an information letter and informed consent forms ($n = 1{,}145$). A total of 307 parents gave their informed consent and all 307 children gave their verbal assent at first assessment. The first assessment took place between January and June 2011. The following assessments took place as close as possible to the same date 12 and 24 months later.

Child assessment. Administration of the SPPC took place in a quiet room at school. Because the children in the current study were younger than the children in previous studies using this questionnaire, great care was taken (particularly during the first year of questionnaire administration) to ensure that the children understood the questions being asked. All questions were read out loud to all the children.

1 Children in Dutch elementary schools are free on Wednesday afternoons.

Parental assessment. The 7-day activity diaries were distributed in the same month for all children because of large known seasonal differences in the Netherlands. Parents received their 7-day activity diary in May and returned it in May or June because weather conditions are fairly comparable in these months and are generally good. Moreover, there is more variation in physical activity between children in months with more sun hours, like May and June (Carson & Spence, 2010; Tucker & Gilliland, 2007).

Analysis

We used a cohort-sequential design to investigate the change in global self-esteem, perceived athletic competence, and MVPA. This design provides a way to link cohorts to determine if there is a common developmental growth curve (e.g., Duncan, Duncan, Strycker, & Chaumeton, 2007). In this way, it is possible to connect several short-term longitudinal studies of different age cohorts to investigate the change in global self-esteem, perceived athletic competence, and MVPA over a longer period of time. For the change in global self-esteem and the change in perceived athletic competence, we used second-order latent growth curve models. This means that the growth curve was fitted on latent variables, so that measurement errors were taken into account. All analyses were performed using Bayesian statistics.

Firstly, we performed several preliminary analyses to make sure latent growth curve analyses could be investigated accordingly. Preliminary analysis consisted of testing for longitudinal measurement invariance of the indicators in this model, which is a prerequisite for comparing common factors across time (McArdle, 2009; Oort, 2001). Because we used Bayesian statistics, well-known fit indices (e.g., Chi-square, RMSEA, CFI) were not available. Instead, Deviance Information Criterion (DIC) was used to compare models with each other (Spiegelhalter, Best, Carlin, & Van der Linde, 2002). We also tested for invariance in global self-esteem and perceived athletic competence for gender and age, and, finally, we tested for dependence due to the nested structure in the data because children were clustered within school.

Secondly, we conducted a linear growth model (McArdle, 1988; Meredith & Tisak, 1990) on both indicators for MVPA and common factors for global self-esteem and perceived athletic competence that assumed that the change in global self-esteem, perceived athletic competence, and MVPA can be modeled with an intercept (initial status) and slope (linear change), which can vary across children (the intercept and slope may have variance).

Thirdly, if significant variance on intercept or slope between children was found we added gender as a covariate to investigate whether gender could explain part of the variance in intercept and slope in global self-esteem, perceived athletic competence, and MVPA. Explained variance (R^2) of the intercept and slope was reported.

Finally, we investigated associations between the change in global self-esteem, perceived athletic competence, and MVPA. Using multigroup models, we tested whether these associations differed across gender.

Statistical analyses were performed in M*plus* 7.0, using Bayesian estimation with the default settings in the program. M*plus* provides 95% confidence intervals for parameter estimates, which gives a 95% probability that the population parameter will lie between the lower and upper value of the interval. For more information about Bayesian methods in general see Lynch (2007); for the specific implementation in M*plus*, see Muthén (2010). M*plus* also provides *p* values for parameter estimates, which are related to the confidence intervals. They were evaluated against a significance level of .05.

Results

Preliminary analyses

All tables with the results of the preliminary analyses are reported in the Supplementary Tables S2.1, S2.2, and S2.3. Firstly, to test the factor structure of the SPPC subscales for global self-esteem and perceived athletic competence, for each subscale we investigated the model where all indicators were allowed to load freely on global self-esteem or perceived athletic competence ($n = 292$) (Model I). To check for invariance of the factor loadings and intercepts between grades, we investigated the same model again where we assumed factor loadings and intercepts to be the same for every year (Model II). With regard to global self-esteem, M*plus* was unable to arrive at a solution when fitting Model I, but was able to fit Model II (DIC = 10964.842). With regard to perceived athletic competence, surprisingly, Model II showed a worse fit to the data (DIC Model I: 12871.242; DIC Model II: 12902.255). However, because constrained factor loadings and intercepts are an important prerequisite for latent growth curves, we used Model II to perform all analyses[2].

Secondly, we tested for invariance in global self-esteem and perceived athletic competence for gender and grade. Test statistics from these analyses can be found in Supplementary Table S2.3. We found that all items were measurement invariant across boys and girls in

2 We also analyzed Model I and added gender as a covariate (Model Ia). The results of Model Ia were similar to the results of Model IIa.

2

every grade, with the exception of one item in grade 1 where the factor loading was higher for girls. We also found that all perceived athletic competence items were invariant across boys and girls in every grade, with the exception of one item in kindergarten where the factor loading was also higher for girls. These small differences will not affect the results. With regard to age, we tested invariance in global self-esteem and perceived athletic competence between children in kindergarten and grade 4 as possible age differences were expected to be largest between the youngest and the oldest children. We found no measurement non-invariance in global self-esteem, but did find differences on two items in perceived athletic competence. The intercept of one item was higher in children in kindergarten, while intercept of the other item was higher in children in grade 4.

Thirdly, because the children were clustered within schools, it would be desirable to correct for the nested structure in the analysis. However, the option to correct for the multilevel structure is not available with Bayesian estimation in M*plus*. Ignoring nestedness may lead to inflated type I errors (Snijders & Bosker, 1999). However, effects on parameter estimates in a factor model are found to be ignorable when ICC < .15, and the influence on standard errors is very small when ICC < .25 and ignorable when ICC < .05 (Pornprasertmanit, Lee, & Preacher, 2014). The item's ICCs for schools ranged between .00 and .19 for global self-esteem, between .01 and .13 for perceived athletic competence, and between .00 and .07 for physical activity.

Developmental changes

Global self-esteem (mean slope: .02, 95% CI: -.01, .04, $p = .170$), perceived athletic competence (mean slope: -.02, 95% CI: -.05, .01, $p = .154$), and MVPA (mean slope: .01, 95% CI: .00, .02, $p = .222$) stayed the same over time from kindergarten to grade 4.

We added gender to the model to investigate if gender explained some of the variance and slope between children. Global self-esteem was the same in boys and girls in kindergarten (*b*: -.02, 95% CI: -.14, .10, $p = .706$), but boys perceived themselves higher in athletic competence (*b*: -.19, 95% CI: -.35, -.04, $p = .008$) and participated more in MVPA (*b*: -.04, 95% CI: -.08, .00, $p = .042$) than girls in kindergarten.

The change in global self-esteem (*b*: .03, 95% CI: -.01, .08, $p = .132$), perceived athletic competence (*b*: .05, 95% CI: -.01, .11, $p = 114$), and MVPA (*b*: .00, 95% CI: -.02, .02, $p = .756$) was the same in boys and girls, although the average slope of perceived athletic competence for boys was significantly negative (mean slope boys: -.05, 95% CI: -.09, .00, $p = .038$). Results of the developmental changes are presented in Table 2.2.

Table 2.2 Parameter estimates and confidence intervals of the models with gender predicting the latent intercept and slope of GSE, PAC and PA

	GSE (*n* = 292)			PAC (*n* = 292)			PA (*n* = 184)		
	Est. (Unst.)	95% CI (Unst.)	Est. (Stand.)	Est. (Unst.)	95% CI (Unst.)	Est. (Stand.)	Est. (Unst.)	95% CI (Unst.)	Est. (Stand.)
Intercept (mean)	.00	–	.00	.00	–	.00	.32*	[.30, .34]	3.99*
Slope (mean)	.02	[-.01, .04]	.22	-.02	[-.05, .01]	-.31	.01	[.00, .02]	.19
Intercept with slope (covariance)	-.01*	[-.03, .00]	-.71*	.00	[-.04, .01]	-.42	.00	[.00, .00]	-.27
Intercept on gender (*b*)	-.02	[-.14, .10]	-.04	-.19*	[-.35, -.04]	-.31*	-.04*	[-.08, .00]	-.26*
Slope on gender (*b*)	.03	[-.01, .08]	.22	.05	[-.01, .11]	.33	.00	[-.02, .02]	-.05
R^2 intercept	.01			.10*			.06*		
R^2 slope	.05			.11			.01		

Note. Est. = estimate; CI = confidence interval; GSE = global self-esteem; PAC = perceived athletic competence; PA = physical activity; Unst. = unstandardized; Stand. = standardized.
* $p < .05$.

Longitudinal associations

We investigated associations between the change in global self-esteem, perceived athletic competence, and MVPA by combining the separate growth models and looking at the covariance between the two change (slope) factors.

The change in global self-esteem was not significantly associated with the change in perceived athletic competence (*cov*: .00, 95% CI .00, -.01, $p = .218$). This association was not significant in boys (*cov*: .01, 95% CI: .00, .01, $p = .088$), but was significant in girls (*cov*: .03, 95% CI: .02, .06, $p < .001$). Subsequently, the association was significantly different between boys and girls ($cov_{boys} - cov_{girls}$: .27, 95% CI: .01, .06, $p < .001$).

To investigate associations with MVPA we were forced to use only global self-esteem and perceived athletic competence data of children whose parents had completed activity diaries ($n = 184$). As this was a subset of our sample, we investigated differences in prognostic factors between the sample of 292 children and the sample of 184 children. The samples of children were the same with regard to sex, $\chi^2(1, n = 292,) = 1.33$, $p = .248$, and number of children per cohort, $\chi^2(1, n = 292) = 0.13$, $p = .716$, but the sample with 184 children consisted of significantly fewer children from non-western ethnic minorities than the sample with 292 children, $\chi^2(1, n = 292) = 22.49$, $p < .05$.

The change in perceived athletic competence was not significantly associated with the change in MVPA (*cov*: .00, 95% CI: .00, .00, $p = .112$). This association was not significantly associated with the change in MVPA in boys (*cov*: .00, 95% CI: .00, .01, $p = .324$), or in girls (*cov*: .00, 95% CI: .00, .01, $p = .676$). The association was also not significantly different between boys and girls ($cov_{boys} - cov_{girls}$: .00, 95% CI: -.01, .00, $p = .644$).

The change in MVPA was also not significantly associated with the change in global self-esteem (*cov*: .00, 95% CI: .00, .00, $p = .234$). This association was not significant in boys (*cov*: .00, 95% CI: .00, .01, $p = .498$), but was significant in girls (*cov*: .01, 95% CI: .00, .01, $p = .032$). However, the association was not significantly different between boys and girls ($cov_{boys} - cov_{girls}$: .00, 95% CI: .00, .01, $p = .264$).

Discussion

Developmental changes

As hypothesized, global self-esteem remained stable over time. This result is in line with the results found by Wigfield and Eccles (1994). However, unexpectedly, we found that perceived athletic competence remained stable over time. This in contrast with an extensive number of studies in which perceived athletic competence declined during childhood (e.g., Fredricks & Eccles, 2002; Jacobs et al., 2002; Wigfield et al., 1997). Although perceived athletic competence declines during childhood, the developmental change in perceived athletic competence is less clear during the elementary school period. Perceived athletic competence is found to decline during the elementary school period (Wigfield et al., 1997), but is also found to increase (Cole et al., 2001) during the elementary school period. Now, we found that perceived athletic competence remained stable during the elementary school period, indicating that more research is necessary to understand the developmental changes in perceived athletic competence during this period in childhood. An explanation for the stability of perceived athletic competence during our study period focuses on the age of the children. Because children were still fairly young, especially children in cohort I (e.g., from kindergarten to grade 2), we speculate that they were not yet comparing their performance with their peers, which is thought to be the primary reason for the decline in perceived athletic competence (Harter, 2006).

We also found, unexpectedly, that MVPA remained stable over time. This result is in contrast with an extensive number of studies that show that MVPA declines over time (e.g., Basterfield et al., 2011; Cleland et al., 2010). An explanation for the unexpected stability of physical activity during our study period focuses on a combination of cultural and age differences. Dutch children in kindergarten and the first years of elementary school are (strongly) encouraged to participate in organized sport activities (e.g., soccer and hockey) by their parents. Moreover, during elementary school the large majority of children in the Netherlands learn how to swim, and their main transportation between home, school, friends, and sport activities is by bike. We speculate that MVPA remained stable because of a (fairly) consistent cultural daily routine after school that is promoted by parents of younger children.

Longitudinal associations

Unexpectedly, we found no associations between the change in global self-esteem, perceived athletic competence, and MVPA. The findings are not consistent with the hypothesized associations as described in the EXSEM (Sonstroem et al., 1994). Other self-perceptions are possibly important to explain the association between global self-esteem and MVPA (Fox & Corbin, 1989).

With regard to the association between perceived athletic competence and MVPA, as argued before, we speculate that MVPA in younger Dutch children is strongly influenced by their parents. Therefore, younger children have less opportunity to choose their own physical activity behavior. As a result, perceived athletic competence, which is believed to enhance *intrinsic* motivation (Harter, 1981), might have a smaller influence on physical activity behavior in these younger children. Also, Eccles et al. (1983) points out in the Expectancy-Value model that significant others (e.g., parents) play an important role as providers of experience for children.

Differences between boys and girls

As hypothesized, we found that global self-esteem was the same in boys and girls, and that boys had higher scores for perceived athletic competence and participated more in MVPA than girls in kindergarten. Global self-esteem remained, as expected, stable over time in boys and girls. Perceived athletic competence declined over time in boys, but remained stable in girls. This change in perceived athletic competence was however not significantly different between boys and girls. We found, unexpectedly, a significant decline in boys, which was not significantly different compared with the more stable perceived athletic competence in girls. An explanation for this decline in perceived athletic competence in boys focusses on their participation in MVPA. Because boys participated more in MVPA than girls, they were also more exposed to situations in which they could compare their athletic performance with their peers, resulting in a decline in perceived athletic competence.

The difference in MVPA remained the same between boys and girls, while we hypothesized that this difference in MVPA between boys and girls would become larger over time. As mentioned before, we speculate that MVPA remained stable because of a fairly consistent cultural daily routine after school that is promoted by parents of younger children. Girls were possibly already on a minimum of MVPA as promoted by their parents when they were in kindergarten, causing participation in MVPA to remain stable over time.

Surprisingly, the change in global self-esteem and the change in perceived athletic competence, and the change in global self-esteem and the change in MVPA, was significant in girls, but not in boys. This result is (partly) in contrast to other longitudinal studies. Significant associations have been found in both boys and girls, with even stronger associations in boys (e.g., Schmidt, Blum, Valkanover, & Conzelmann, 2015). We have no clear explanation for our results. However, it has been suggested that girls are more likely to attribute success to their own ability and failure to a lack of their own ability (internal locus of control), while boys are more likely to attribute success and failure to powerful others or unknown causes (external locus of control) (Wigfield, Battle, Keller, & Eccles, 2002). In doing so, less participation in MVPA or lower levels of perceived athletic competence would impact global self-esteem in girls, but not in boys. Additionally, the change in perceived athletic competence and the change in MVPA were fairly similar in boys and girls. This would explain why the association was not different in boys and girls, which was in line with our hypothesis.

Weaknesses and strengths of the study

Several limitations of the study have to be recognized. Firstly, we investigated MVPA using 7-day activity dairies completed by the children's parent(s). Some researchers argue that the validity and reliability of activity diaries are questionable (Chinapaw, Mokkink, Van Poppel, Van Mechelen, & Terwee, 2010). This is especially the case when *intensity* in physical activity is measured. However, we were interested in the *amount* of MVPA instead of the *intensity* of physical activity. We, therefore, dichotomized every time block as *MVPA* or *no physical activity* thereby introducing less variation and higher accuracy for the physical activity measurement. Using this approach we reached high inter-rater reliability with only (initial) disagreement between assessors in less than 1 percent of the time blocks. Secondly, we investigated only "after school MVPA" instead of the total amount of MVPA, which also includes school-based activity. We have therefore no complete picture of the child's total physical activity behavior, which possibly influenced the association between MVPA and both global self-esteem and perceived athletic competence. Thirdly, a large number of parents did not fill in the activity diary (n = 108; 37% of the sample initially approached). Associations with MVPA were therefore analyzed in only 184 children instead of the 292 children that participated in the Move Along study. Moreover, the ratio between children from non-western ethnic minorities and Caucasian children was significantly lower in the sample of parents who did not complete the activity diaries. We argue that there are two possible explanations for this result. To begin with, parents need to have a considerable understanding of the Dutch language to fill in the activity diaries, which might not have always been the case in parents from ethnic minorities. Also, children and adults from non-western ethnic minorities in the Netherlands are less physically active than Caucasian children and adults (Hildebrandt, Bernaards, Chorus, & Hofstetter, 2013). Parents from non-western ethnic minorities might therefore have felt less inclined to fill in activity diaries. Fourthly, we investigated *associations*, as opposed to directional effects, between the change in global self-esteem, perceived athletic competence, and MVPA. In the EXSEM, a skill-development pathway is hypothesized whereby participation in specific behavior (e.g., physical activity) will influence global self-esteem, through the mediation of more specific self-perceptions (e.g., perceived athletic competence). However, the opposite direction of effects, a self-enhancement pathway, is also possible (Harter, 2006), that is, a higher global self-esteem is hypothesized to lead to positive specific perceptions (e.g., perceived athletic competence), which will result in a greater likelihood of engaging in specific behavior (e.g., physical activity). Future research may focus on contrasting different models that may underlie the associations that we found. Finally, we investigated associations between the change in global self-esteem, perceived athletic competence, and MVPA on a between-person level. Technically, it is possible to investigate across construct associations between time point specific within-person deviations from the average growth curve (Lindwall, Asci, & Crocker, 2014). Although of interest, this was beyond the scope of our article.

In terms of the strengths of our study, firstly, this is one of the first studies that has investigated psychological constructs, such as perceived athletic competence and global self-esteem, in relation to MVPA in elementary school children. Secondly, we used a longitudinal design to investigate the change in, and associations between, global self-esteem, perceived athletic competence, and MVPA from a developmental perspective. Thirdly, we investigated the change in global self-esteem and perceived athletic competence on a latent level. By fitting the growth model on factors instead of scale scores, measurement error at the item level was taken into account by the measurement model (e.g., Preacher, Wichman, MacCallum, & Briggs, 2008).

In sum, this study expands the knowledge on the change in, and associations between, global self-esteem, perceived athletic competence, and MVPA in elementary school children. Global self-esteem, perceived athletic competence, and MVPA were stable between kindergarten and grade 4. Global self-esteem was the same in boys and girls, while perceived athletic competence and MVPA was higher in boys. Associations between the change in global self-esteem with perceived athletic competence and MVPA were significant in girls, but not in boys. We found large variance in the change in global self-esteem, perceived athletic competence, and MVPA, indicating that there were other determinants that influenced the developmental changes. Future research should focus on the determinants of these developmental changes in elementary school children. Early recognition and intervention with children with low MVPA and/or low global self-esteem might prevent problems in health related outcomes, life satisfaction, and depression in middle school and high school.

Acknowledgements

We thank the teachers, parents, and students who made this research possible. Also, we are grateful to prof. dr. H. J. A. Hoijtink for his contribution to the statistical analyses.

Highlights

In children from kindergarten to grade 4:

- Global self-esteem, perceived athletic competence, and physical activity remain stable
- Global self-esteem is the same in boys and girls
- Boys have a higher perceived athletic competence and are more physically active
- Perceived athletic competence is associated with global self-esteem in girls
- Global self-esteem is associated with physical activity in girls

References

Aznar, S., Naylor, P. J., Silva, P., Perez, M., Angulo, T., Laguna, M., . . . Lopez-Chicharro, J. (2011). Patterns of physical activity in Spanish children: A descriptive pilot study. *Child: Care, Health and Development, 37*, 322-328. doi: 10.1111/j.1365-2214.2010.01175.x

Babiss, L. A., & Gangwisch, J. E. (2009). Sports participation as a protective factor against depression and suicidal ideation in adolescents as mediated by self-esteem and social support. *Journal of Developmental and Behavioral Pediatrics, 30*, 376-384. doi: 10.1097/DBP.0b013e3181b33659

Basterfield, L., Adamson, A. J., Frary, J. K., Parkinson, K. N., Pearce, M. S., & Reilly, J. J. (2011). Longitudinal study of physical activity and sedentary behavior in children. *Pediatrics, 127*, e24-30. doi: 10.1542/peds.2010-1935

Biddle, S. J. H., & Asare, M. (2011). Physical activity and mental health in children and adolescents: A review of reviews. *British Journal of Sports Medicine, 45*, 886-895. doi: 10.1136/bjsports-2011-090185

Bouchard, C., Tremblay, A., Leblanc, C., Lortie, G., Savard, R., & Theriault, G. (1983). A method to assess energy expenditure in children and adults. *The American Journal of Clinical Nutrition, 37*, 461-467.

Calame, E., Reinders, H., Smits-Engelsman, B. C. M., Schoemaker, M. M., Volman, M. J. M., & De Kloet, A. (2009). *Hoe ik vind dat ik het doe vragenlijst: Vragenlijst motorische competentiebeleving (How am I Doing questionnaire: A questionnaire to investigate perceived motor competence).* Unpublished manuscript.

Carson, V., & Spence, J. C. (2010). Seasonal variation in physical activity among children and adolescents: A review. *Pediatric Exercise Science, 22*, 81-92.

Chinapaw, M. J., Mokkink, L. B., Van Poppel, M. N., Van Mechelen, W., & Terwee, C. B. (2010). Physical activity questionnaires for youth: A systematic review of measurement properties. *Sports Medicine, 40*, 539-563. doi: 10.2165/11530770-000000000-00000

Cleland, V., Timperio, A., Salmon, J., Hume, C., Baur, L. A., & Crawford, D. (2010). Predictors of time spent outdoors among children: 5-year longitudinal findings. *Journal of Epidemiology & Community Health, 64*, 400-406. doi: 10.1136/jech.2009.087460

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

Duncan, S. C., Duncan, T. E., Strycker, L. A., & Chaumeton, N. R. (2007). A cohort-sequential latent growth model of physical activity from ages 12 to 17 years. *Annals of Behavioral Medicine, 33*, 80-89. doi: 10.1207/s15324796abm3301_9

Eccles, J. S., Adler, T. F., Futterman, R., Goff, S. B., Kaczala, C. M., Meece, J. L., & Midgley, C. (1983). Expectancies, values, and academic behaviors. In J. T. Spence (Ed.), *Achievement and achievement motivation* (pp. 77-146). San Fransico, CA: W.H. Freeman.

Fox, K. R., & Corbin, C. B. (1989). The physical self-perception profile: Development and preliminary validation. *Journal of Sport and Exercise Psychology, 11*, 408-430. doi:10.1037/t05399-000

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

Gentile, B., Grabe, S., Dolan-Pascoe, B., Twenge, J., Wells, B., & Maitino, A. (2009). Gender differences in domain-specific self-esteem: A meta-analysis. *Review of General Psychology, 13*, 34-45. doi:10.1037/a0013689

Harter, S. (1981). A model of mastery motivation in children: Individual differences and developmental change. In A. Collins (Eds.), *Minnesota Symposium on Child Psychology* (pp. 215-255). Hillsdale, NJ: Lawrence Erlbaum Associates.

Harter, S. (1999). *The construction of the self: A developmental perspective*. New York: Guildford Press.

Harter, S. (2006). The self. In N. Eisenberg, W. Damon, & R. M. Lerner (Eds.), *Handbook of Child Psychology, 6th Edition, Volume 3: Social, Emotional, and Personality Development* (pp. 505-570). Hoboken, NJ: John Wiley & Sons.

Henderson, S. E., Sugden, D. A., & Barnett, A. (2007). *Movement assessment battery for children - second edition [Movement ABC-2]*. London: The Psychological Corporation.

Hildebrandt, V., Bernaards, C., Chorus, A., & Hofstetter, H. (2013). Bewegen in Nederland 2000-2011. In V. H. Hildebrandt, C. M. Bernaards, & J. H. Stubbe (Eds.), *Trendrapport Bewegen en Gezondheid 2010/2011* (pp. 9-50). Leiden: TNO.

Jacobs, J. E., Lanza, S., Osgood, D. W., Eccles, J. S., & Wigfield, A. (2002). Changes in children's self-competence and values: Gender and domain differences across grades one through twelve. *Child Development, 73*, 509-527. doi: 10.1111/1467-8624.00421

Kling, K. C., Hyde, J. S., Showers, C. J., & Buswell, B. N. (1999). Gender differences in self-esteem: A meta-analysis. *Psychological Bulletin, 125*, 470-500. doi:10.1037/0033-2909.125.4.470

Lindwall, M., Asci, H., & Crocker, P. (2014). The physical self in motion: Within-person change and associations of change in self-esteem, physical self-concept, and physical activity in adolescent girls. *Journal of Sport and Exercise Psychology, 36*, 551-563. doi: 10.1123/jsep.2013-0258

Lynch, S. (2007). Introduction to applied Bayesian statistics and estimation for social scientists. New York: Springer

Manios, Y., Kafatos, A., & Markakis, G. (1998). Physical activity of 6-year-old children: Validation of two proxy reports. *Pediatric Exercise Science, 10*, 176-188.

Marsh, H. W. (1990). A multidimensional, hierarchical model of self-concept: Theoretical and Empirical Justification. *Educational Psychology Review, 2*, 77-172. doi:10.1007/bf01322177

Marsh, H. W., & Craven, R. G. (1997). Academic self-concept: Beyond the dustbowl. In G. Phye (Ed.), *Handbook of classroom assessment: Learning, achievement and adjustment*. San Diego, CA: Academic Press.

Marsh, H. W. & O'Mara, A. (2008). Reciprocal effects between academic self-concept, self-esteem, achievement, and attainment over seven adolescents years: Unidimensional and multidimensional perspectives of self-concept. *Personality and Social Psychology Bulletin, 34*, 542-552. doi: 10.1177/0146167207312313

Marsh, H. W., & Shavelson, R. (1985). Self-concept: Its Multifaceted, hierarchical structure. *Educational Psychologist, 20*, 107-123. doi: 10.1207/s15326985ep2003_1

McArdle, J. J. (1988). Dynamic but structural equation modeling of repeated measures data. In J. R. Nesselroade & R. B. Cattell (Eds.), *Handbook of multivariate experimental psychology: Perspectives on individual differences* (pp. 561-614): New York, NY: Plenum Press.

McArdle, J. J. (2009). Latent variable modeling of differences and changes with longitudinal data. *Annual Review of Psychology, 60*, 577-605. doi: 10.1146/annurev.psych.60.110707.163612

Meredith, W., & Tisak, J. (1990). Latent curve analysis. *Psychometrika, 55*, 107-122.

Moos, R. H., & Moos, B. S. (1994). *Family environment scale manual - third edition*. Palo Alto, CA: Consulting Psychologists Press.

Morin, A. J., Maiano, C., Marsh, H. W., Nagengast, B., & Janosz, M. (2013). School life and adolescents' self-esteem trajectories. *Child Development, 84*, 1967-1988. doi: 10.1111/cdev.12089

Muris, P., Meesters, C., & Fijen, P. (2003). The self-perception profile for children: Further evidence for its factor structure, reliability, and validity. *Personality and Individual Differences, 35*, 1791-1802. doi: 10.1016/s0191-8869(03)00004-7

Muthen, B. (2010). *Bayesian analysis in MPlus: A brief introduction.* Unpublished manuscript. Retrieved from www.statmodel.com

Oort, F. J. (2001). Three-mode models for multivariate longitudinal data. *The British Journal of Mathematical and Statistical Psychology, 54*, 49-78. doi: 10.1348/000711001159429

Paradise, A. W., & Kernis, M. H. (2002). Self-esteem and psychological well-being: Implications of fragile self-esteem *Journal of Social and Clinical Psychology, 21*, 345-361. doi: 10.1521/jscp.21.4.345.22598

Pornprasertmanit, S., Lee, J., & Preacher, K. J. (2014). Ignoring clustering in confirmatory factor analysis: Some consequences for model fit and standardized parameter estimates. *Multivariate Behavioral Research, 49*, 518-543. doi:10.1080/00273171.2014.933762

Preacher, K. J., Wichman, A. L., MacCallum, R. C., & Briggs, N. E. (2008). *Latent Growth Curve Modeling.* Thousand Oaks, CA: SAGA Publications, Inc.

Rosenberg, M., Schooler, C., Schoenback, C., & Rosenberg, F. (1995). Global self-esteem and specific self-esteem: Different concepts, different outcomes. *American Sociological Review, 60*, 141-156. doi: 10.2307/2096350

Schmidt, M., Blum, M., Valkanover, S., & Conzelmann, A. (2015). Motor ability and self-esteem: The mediating role of physical self-concept and perceived social acceptance. *Psychology of Sport and Exercise, 17*, 15-23. doi: doi:10.1016/j.psychsport.2014.11.006

Shavelson, R. J., Hubner, J. J., & Stanton, G. C. (1976). Self-concept: Validation of construct interpretations. *Review of Educational Research, 46*, 407-441. doi:10.3102/00346543046003407

Sonstroem, R. J., Harlow, L. L., & Josephs, L. (1994). Exercise and self-esteem: Validity of model expansion and exercise associations. *Journal of Sport and Exercise Psychology, 16*, 29-42.

Sonstroem, R. J. & Morgan, W. P. (1989). Exercise and self-esteem. *Medicine & Science in Sport & Exercise, 21*, 329-337. doi: 10.1249/00005768-198906000-00018

Spiegelhalter, D. J., Best, N. G., Carlin, B. P., & Van der Linde, A. (2002). Bayesian measures of model complexity. *Journal of the Royal Statistical Society: Series B (Statistical Methodoly), 64*, 583-639. doi: 10.1111/1467-9868.00353

Snijders, T. A. B., & Bosker, R. J. (1999). *Multilevel analysis: An introduction to basic and advanced multilevel modeling.* Sage, CA: Thousand Oaks.

Telford, R. M., Telford, R. D., Cunningham, R. B., Cochrane, T., Davey, R., & Waddington, G. (2013). Longitudinal patterns of physical activity in children aged 8 to 12 years: The LOOK study. *The International Journal of Behavioral Nutrition and Physical Activity, 10*, 81. doi: 10.1186/1479-5868-10-81

Trzesniewski, K. H., Donnellan, M. B., & Robins, R. W. (2003). Stability of self-esteem across the life span. *Journal of Personality and Social Psychology, 84*, 205-220. doi: 10.1037/0022-3514.84.1.205

Tucker, P., & Gilliland, J. (2007). The effect of season and weather on physical activity: A systematic review. *Public Health, 121*, 909-922. doi: 10.1016/j.puhe.2007.04.009

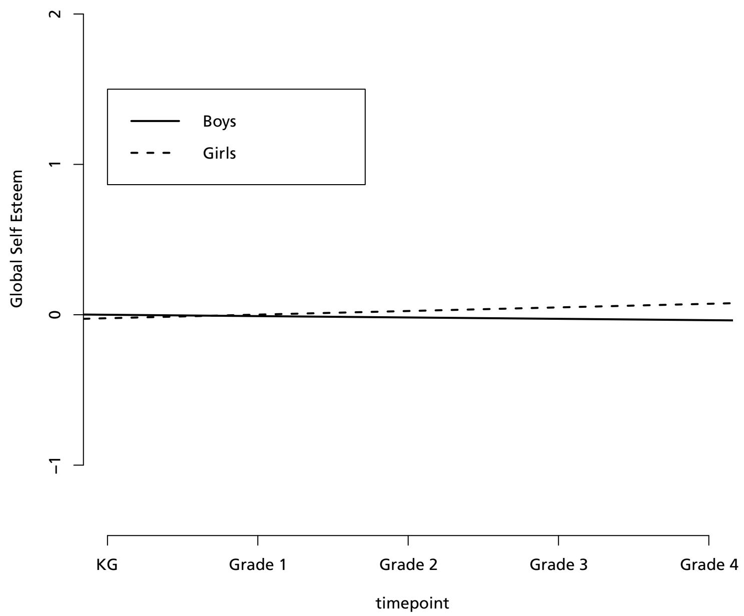
Veerman, J. W., Straathof, M. A. E., Treffers, P. D. A., Van den Bergh, B., & Ten Brink, L. T. (1997). *Handleiding Competentiebelevingsschaal voor Kinderen (CBSK) (Manual for the Dutch version of the SPPC)*. Lisse, The Netherlands: Swets & Zeitlinger.

Wigfield, A., Battle, A., Keller, L. B., & Eccles, J. S. (2002). Sex differences in motivation, self-concept, career aspiration and career choice: Implications for cognitive development. In A. V. M.-D. Lisi & R. D. Lisi (Eds.), *Biology, sociology, and behavior: The development of sex differences in cognition.* (Vol. 21, pp. 93-127). Greenwich, CT: Ablex Publishing.

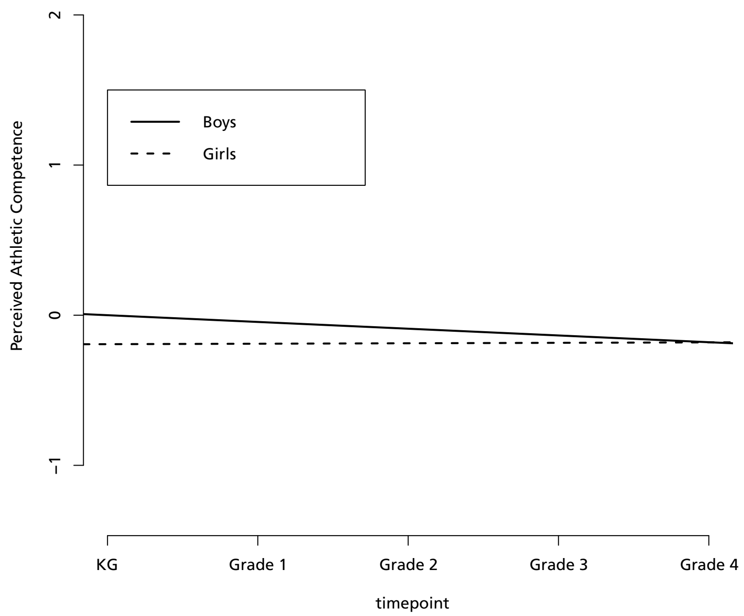
Wigfield, A., & Eccles, J. S. (1994). Children's competence beliefs, achievement values, and general self-esteem: Change across elementary school and middle school. *Journal of Early Adolescence, 14*, 107-138. doi: 10.1177/027243169401400203

Wigfield, A., Harold, R. D., Freedman-Doan, C., Eccles, J. S., Yoon, K. S., Arbreton, A. J., & Blumfield, P. C. (1997). Change in children's competence beliefs and subjective task values across the primary school years: A 3-year study. *Journal of Educational Psychology, 89*, 451-469. doi: 10.1037/0022-0663.89.3.451

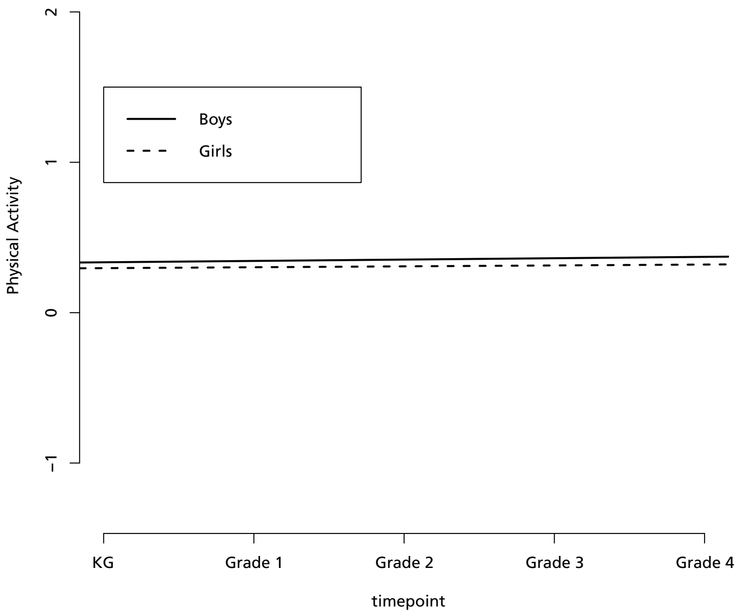
Supplementary material



Supplementary Figure S2.1 Global self-esteem: Average growth curve for boys and girls.



Supplementary Figure S2.2 Perceived athletic competence: Average growth curve for boys and girls.



Supplementary Figure S2.3 Physical activity: Average growth curve for boys and girls.

Supplementary Table S2.1 Deviance Information Criterion (DIC)

	Model I Free estimation	Model II Fixed estimation
	DIC	DIC
GSE (*n* = 292)	-	10964.842
PAC (*n* = 292)	12871.242	12902.255

Note. DIC = Deviance Information Criterion; GSE = global self-esteem; PAC = perceived athletic competence.

Supplementary Table S2.2 Factor loadings of the model with the best fit for perceived athletic competence & global self-esteem per grade

	Perceived athletic competence		Global self-esteem	
	Constrained estimation[a] (standardized) (*n* = 292)	95% CI (*n* = 292)	Constrained estimation[a] (standardized) (*n* = 292)	95% CI (*n* = 292)
Kindergarten				
Q1	.56	[.45, .66]	.45	[.34, .55]
Q2	.31	[.22, .41]	.43	[.33, .54]
Q3	.48	[.38, .59]	.40	[.30, .50]
Q4	.51	[.41, .62]	.49	[.37, .61]
Q5	.28	[.19, .37]	.46	[.35, .57]
Q6	.51	[.40, .62]	.38	[.28, .48]
Grade 1				
Q1	.58	[.48, .69]	.46	[.37, .56]
Q2	.34	[.24, .44]	.50	[.40, .61]
Q3	.59	[.49, .68]	.58	[.48, .67]
Q4	.59	[.47, .70]	.60	[.49, .70]
Q5	.28	[.20, .37]	.53	[.43, .64]
Q6	.59	[.49, .68]	.44	[.34, .55]
Grade 2				
Q1	.54	[.46, .63]	.44	[.36, .53]
Q2	.30	[.22, .38]	.47	[.39, .56]
Q3	.52	[.44, .60]	.55	[.47, .64]
Q4	.54	[.45, .63]	.61	[.53, .69]
Q5	.29	[.22, .38]	.67	[.59, .74]
Q6	.54	[.46, .62]	.42	[.34, .51]
Grade 3				
Q1	.55	[.45, .64]	.40	[.31, .50]
Q2	.28	[.19, .37]	.39	[.30, .48]
Q3	.49	[.39, .59]	.45	[.35, .55]
Q4	.56	[.45, .67]	.60	[.50, .70]
Q5	.35	[.25, .45]	.60	[.49, .70]
Q6	.50	[.41, .60]	.38	[.29, .47]
Grade 4				
Q1	.66	[.56, .75]	.43	[.34, .53]
Q2	.36	[.27, .47]	.45	[.35, .56]
Q3	.67	[.55, .78]	.50	[.40, .60]
Q4	.61	[.52, .70]	.70	[.59, .80]
Q5	.39	[.29, .50]	.62	[.52, .72]
Q6	.71	[.59, .80]	.42	[.32, .52]

Note. CI = confidence interval; Q = questions of the SPPC for Perceived Athletic Competence and Global Self-Esteem.
[a] Factor loadings are equal for every year in the unstandardized model.

Supplementary Table S2.3 Degrees of freedom, χ^2, lower and upper bound of the RMSEA and conclusion about bias for model with strong factorial invariance across gender in each grade

	df	χ^2	Lo RMSEA	Hi RMSEA	MI > 8.21
GSE					
KG	28	45.84	.04	.14	No
Grade 1	28	81.05	.12	.21	Yes[1]
Grade 2	28	35.86	0	.08	No
Grade 3	28	40.85	0	.13	No
Grade 4	28	23.89	0	.07	No
PAC					
KG	28	32.89	0	.11	Yes[2]
Grade 1	28	28.39	0	.09	No
Grade 2	28	46.78	.03	.10	No
Grade 3	28	37.75	0	.12	No
Grade 4	28	62.61	.09	.18	No

Note. KG = kindergarten; GSE = global self-esteem; PAC = perceived athletic competence; MI = modification index for factor loading or intercept. MI's where tested against χ^2 = 8.21, which is the critical value associated with a Bonferroni corrected alpha-level of .05 / 12, where 12 is the number of factor loadings and intercepts under consideration.

[1] item 6 was higher for girls; [2] item 5 was higher for girls.

2

Chapter 3

The change in perceived motor competence and motor task values during elementary school: A longitudinal cohort study

Johannes J. Noordstar
Janjaap van der Net
Suzanne Jak
Paul J.M. Helders
Marian J. Jongmans

British Journal of Developmental Psychology (2016), 34, 427-446

Acknowledgement of authors' contributions:
J.N, J.V.N., P.H., and M.J designed the study; J.N. gathered data; J.N. and S.J. performed the data-analysis; J.N. and S.J. wrote the paper; J.V.N, P.H., and M.J. edited the paper.

Abstract

Participation in motor activities is essential for social interaction and life satisfaction in children. Self-perceptions and task values have a central position in why children do or do not participate in (motor) activities. Investigating developmental changes in motor self-perceptions and motor task values in elementary school children would provide vital information about their participation in motor activities. We therefore examined the change in, and associations between, self-perceptions and task values of fine motor competence, ball competence, and athletic competence in 292 children from kindergarten to grade 4. We also investigated differences between boys and girls, and between children with motor problems and typically developing children. Results indicate that self-perceptions and task values are domain specific and differ between boys and girls, but not between children with motor problems and typically developing children. Self-perceptions were not associated with task values. Educators should address specific self-perceptions to enhance participation into the corresponding motor activities in children between kindergarten and grade 4, and differences in self-perceptions and task values between boys and girls should be taken into account.

Introduction

Self-perceptions and task values are important determinants for children's motivation for achievement behaviour (e.g., Eccles et al., 1983). Various studies have used the Expectancy-Value model (Eccles et al., 1983) as a framework to investigate motivation for math, reading, and sports during childhood (e.g., Jacobs, Lanza, Osgood, Eccles, & Wigfield, 2002). The model states that achievement behaviour is directly influenced by *expectations for success* and *subjective task values*. Expectations for success are, in turn, influenced by a person's ability beliefs and efficacy expectations. Ability beliefs are perceptions of how individuals perceive their current competence for a specific activity, while efficacy expectations are how individuals perceive their ability to do well on upcoming tasks.

Turning to the subjective task values in the Expectancy-Value model, Eccles et al. (1983) distinguished four motivational components of subjective task values: (a) attainment value, (b) intrinsic value, (c) utility value, and (d) costs. More specifically, attainment value refers to the personal importance a task has for a person. Intrinsic value refers to the enjoyment, or interest, a person has in performing the task. Utility value refers to how the task fits into a person's current or future plans, and costs refers to what a person has to give up to perform the task.

During elementary school, children develop and consolidate a variety of motor activities that will help them fully participate in society. However, little is known about how elementary school children's self-perceptions and task values about these motor activities change as they develop. Investigating developmental changes in motor self-perceptions and motor task values in elementary school children would provide insight in important determinants for children's motivation for participation in motor activities. This study focused therefore on the change in, and associations between, *ability beliefs* about motor activities (i.e., perceived motor competence) and the personal importance of being good at motor activities (i.e., motor task values) in children from kindergarten to grade 4.

Developmental changes in perceived motor competence

Studies investigating the change in perceived motor competence have focused specifically on perceived athletic competence. While, without exception, longitudinal studies have noted a decline in perceived athletic competence during childhood, the pathway and the speed of this decline differs between studies. This decline is best described by a negative linear trend during elementary school (Wigfield et al., 1997) that accelerates during middle school (Fredricks & Eccles, 2002; Jacobs et al., 2002). However, Cole et al. (2001) found that perceived athletic competence increased significantly during elementary school and only dropped noticeably during the transition from elementary school to middle school.

All studies found a decline in perceived athletic competence, though when that decline starts differs among studies. Notably, all children have an overly optimistic perceived competence at the beginning of elementary school. As children grow older, their perceived athletic competence declines, resulting in a more realistic self-perception. Marsh and Craven (1997) argued that the reason for this decline in perceived competence comes from an increase in the performance-based feedback children receive from their teachers and parents. In addition, as children's cognitive abilities develop, they become more capable of comparing their performance with their peers instead of with their own previous performance (Harter, 2006).

Developmental changes in perceived motor competence: gender differences

Boys have a higher perceived athletic competence than girls in every grade of elementary and middle school (e.g., Cole et al., 2001; Jacobs et al., 2002). Since the decline in perceived athletic competence is nearly identical for boys and girls, this gender difference is stable over time (Cole et al., 2001; Jacobs et al., 2002). Harter (2006) speculated that, historically, sports have been largely a male domain, and male sport figures would represent more powerful role models than female sport figures, causing gender differences in favour of boys.

However, children need more than just a positive evaluation of their own (general) athletic competence to be motivated to participate in activities in daily life. For example, activities like writing or crafts require fine motor competence, while activities like basketball and soccer require ball competence as well as athletic competence. To our knowledge, no study has investigated these more specific perceptions of fine motor competence and ball competence longitudinally. Distinguishing between the change in perceived fine motor competence, perceived ball competence, and perceived athletic competence could give us more specific insight into the composite perceptions of leisure activities.

Based on the above findings, we hypothesize a linear decline in perceived fine motor competence, perceived ball competence, and perceived athletic competence in boys and girls. We expect boys to perceive themselves as consistently higher for athletic competence than girls. Because many ball activities (e.g., football, basketball) are part of athletic activities, we predict perceived ball competence to be higher in boys than girls as well. However, since *actual* fine motor competence is higher in girls than boys (Junaid & Fellowes, 2006), we expect girls to *perceive* themselves as consistently higher in perceived fine motor competence than boys.

Motor task values

Few studies have investigated the change in motor task values, and those that have focused solely on athletic task values (e.g., the personal importance of being good at athletic activities). In boys, athletic task values change little during elementary school, whereas in girls, they decline rapidly (Fredricks & Eccles, 2002; Jacobs et al., 2002). Jacobs et al. (2002) found strong positive associations between the change in perceptions of athletic ability and task values in boys, but not in girls, during elementary school. For boys, both perceived athletic competence and athletic task values remain relatively high in the first years of elementary school and decline at the same rate in later years. In contrast, for girls, the athletic task values decline rapidly in the first years of elementary school before levelling off, while perceived athletic competence declines more slowly (Jacobs et al., 2002).

Apart from the studies described above, few others have investigated how perceived athletic competence is related to athletic task values. Moreover, to our knowledge, no study has investigated the change in fine motor task values and ball task values or how this change is associated with the change in perceived fine motor competence and perceived ball competence. Investigating the change in motor task values and its association with perceived motor competence would provide insight into important determinants of physical and leisure participation.

We hypothesize that task values are still the same in boys and girls in kindergarten. Ball task values and athletic task values are thought to remain relatively stable in boys between kindergarten and grade 4, but decline in girls. We expect fine motor task values to stay relatively stable in girls between kindergarten and grade 4, but decline in boys. Subsequently, we expect the change in self-perceptions and task values of athletic competence and ball competence to be significantly associated in boys, but not in girls. We expect the change in perceived fine motor competence and fine motor task values to be significantly associated in girls, but not in boys.

Motor performance

School-aged children may experience difficulties in learning and performing motor skills. Various studies have found that children with motor problems are less physically active than their typically developing peers (e.g., Baerg et al., 2011). Cairney et al. (2005) suggest that perceived athletic competence could explain why children with motor problems are less likely to participate in physical activity. Perceived athletic competence is still the same in younger children with motor problems and typically developing children (Pless, Carlsson, Sundelin, & Persson, 2001), but differences start to appear from the age of 7 years (e.g., Poulsen, Ziviani, & Cuskelly, 2006, 2008) and become more pronounced when children grow older (Piek, Baynam, & Barrett, 2006).

Children with motor problems differ in the type and severity of problems they have with activities in daily life: some are related to fine motor difficulties, while others are related to athletic difficulties. It stands to reason that perceived competence is linked to the problematic activities. Hence, gross motor difficulties are associated with perceived athletic competence in children with motor problems, while fine motor difficulties are not associated with perceived athletic competence (Piek et al., 2006). Distinguishing between the types of motor problems would give us vital information for future intervention programs for children with motor problems.

We therefore investigated differences in the change in perceived motor competence and motor task values between children with motor problems and typically developing children. Based on the above-described literature, we hypothesize that perceived motor competence is still the same in kindergarten, but we expect a steeper decline in perceived motor competence in children with motor problems than in typically developing children. To our knowledge, no study investigated the change in motor task values, or the associations between perceived motor competence and motor task values, in children with motor problems. We have therefore no clear hypothesis about differences in the change in motor task values between children with motor problems and typically developing children. We furthermore expect the change in perceived motor competence and motor task values to be significantly associated in typically developing children from kindergarten to grade 4, but are again unable to make a clear hypothesis about this association in children with motor problems.

To summarize, this study investigates the change in, and associations between, self-perceptions and task values of fine motor competence, ball competence, and athletic competence from kindergarten to grade 4. We also investigate differences between boys and girls, and between children with motor problems and typically developing children.

Methods

The current study is part of the larger 'Move Along' [Beweeg Je Mee] longitudinal study (Noordstar, Van der Net, Jak, Helders, & Jongmans, 2016). The Medical Research Ethics Committee of the University Medical Centre Utrecht approved this study.

Participants

After receiving approval from the principals of thirteen primary schools, the parents of all children in kindergarten and grade 2 received an information letter and informed consent forms (n = 1,145). A total of 307 parents gave their informed consent. Ten children dropped out during the course of the study. As we used latent growth curve modeling for our statistical analyses, equal numbers of responses from each participant were not required. Children with missing data were, therefore, not excluded from the analysis but contributed less to the result. Some children (n = 13) had to repeat a grade or were referred to a school for special education (n = 2) during the course of the study. Because we used grade as the time interval to investigate the change in perceived motor competence and motor task values, we decided to exclude these children. Therefore, a total of 292 children divided over two cohorts were included in this study. The first assessment took place between January and June 2011 (Time 1). The following assessments took place as close as possible to the same date 12 (Time 2) and 24 (Time 3) months later. Cohort I consisted of children in kindergarten (n = 146; 80 boys), while cohort II consisted of children in grade 2 (n = 146; 68 boys). Children in cohort I were 5.36 (0.52) years and children in cohort II were 7.38 (0.52) years at first assessment.

We used the Movement Assessment Battery for Children - Second Edition (MABC-2) to investigate motor performance to identify children with motor problems (Henderson, Sugden, & Barnett, 2007). This test is divided into three different age bands (3–6 years, 7–10 years, and 11–16 years) each consisting of eight items to measure children's motor performance. The eight items are divided into three subsets: manual dexterity (three items), aiming and catching (two items), and balance (three items). Raw scores are converted into standard scores (1–19) and percentile scores (0–100) so results can be compared with peers. Scores above the 16^{th} percentile are regarded as normal motor performance. Scores between the 6^{th} and 16^{th} percentile are considered "at risk" for motor difficulties and scores below the 6^{th} percentile indicate significant motor difficulties. The MABC-2 has reasonable to good clinical utility in identifying children with motor performance differences (Brown & Lalor, 2009).

The MABC-2 was carried out on Time 1, Time 2, and Time 3. Children were categorized as having motor problems for a specific subset if they scored ≤ 16^{th} percentile on at least two measurement occasions to ensure motor problems were persistent over time, resulting in 31 children (25 boys) with motor problems in their fine motor competence, 8 children (3 boys) with motor problems in their ball competence, and 2 children (1 boy) with motor problems in their balance (Table 3.1).

Table 3.1 Characteristics of the children

	Cohort I *n* = 146	Cohort II *n* = 146
Gender (boys / girls)	80 / 66	68 / 78
Ethnicity (Caucasian / Ethnic minorities)	121 / 25	119 / 27
Motor performance (TD / MP)		
Fine motor competence	126 / 16	128 / 15
Ball competence	140 / 2	137 / 6
Balance	140 / 2	143 / 0
Mean age (*SD*)		
Time 1	5.36 (.52)	7.38 (.52)
Time 2	6.34 (.52)	8.38 (.52)
Time 3	7.34 (.52)	9.37 (.51)

Note. TD = typically developing children; MP = children with motor problems.

Measures

How Am I Doing questionnaire

Perceived motor competence and motor task values were assessed by asking children to complete the How Am I Doing questionnaire (Calame et al., 2009). This questionnaire consists of 13 items that can be divided into three subsets: fine motor activities (five items), ball activities (three items), and athletic activities (five items). Every activity is scored on a 4-point-scale (maximum score 52) with higher scores indicating a more positive perception of motor competence or motor task values. The questionnaire was developed for children aged 6 to 12 years. Firstly, children were presented a photo of a specific motor activity (e.g., throwing, climbing, handwriting) and were asked how they perceived themselves in performing the specific motor activity, e.g., “how good do you perceive yourself at climbing” (perceived motor competence). Secondly, for every item children were asked how important it was for them to be good at performing this specific motor activity, e.g., “how important is it for you to be good at climbing” (motor task value).

Previously reported internal consistency (Cronbach's alpha) was acceptable for perceived fine motor competence (α = .60), perceived ball competence (α = .64), and perceived athletic competence (α = .63). Internal consistency was only reported for the total score of motor task values, but found acceptable (α = .66) (Volman, 2009). In our sample, Cronbach's alpha differed per subscale and, overall, increased as children became older (i.e., perceived fine motor competence (α = .15–.52), perceived ball competence (α = .24–.59), perceived athletic competence (α = .32–.52), fine motor task values (α = .48–.72), ball task values (α = .24–.59), and athletic task values (α = .45–.64) (see Supplementary Table S3.1 for Cronbach's alpha's per grade). Scores on the How Am I Doing questionnaire are reported in Table 3.2, 3.3, and 3.4.

Procedure

Children were individually assessed in a quiet room at their school. Because the children in the current study were younger than children in previous studies using this questionnaire, great care was taken to ensure that the children understood the questions being asked. All questions were read out loud to all the children.

Analysis

We used a cohort-sequential design to investigate the change in perceived motor competence and motor task values. This cohort-sequential design provides a way to link cohorts to determine if there is a common developmental growth curve (Duncan, Duncan, Strycker, & Chaumeton, 2007; Schaie, 1965). In this way, it is possible to connect several short-term longitudinal studies of different age cohorts to investigate the change in perceived motor competence and motor task values over a longer period of time. The growth curve of perceived motor competence and motor task values was fitted on latent variables, implying that measurements errors are taken into account. We constrained intercepts and factor loadings to be equal across years, which is an important prerequisite for comparing common factors across time (McArdle, 2009; Oort, 2001) (see the Supplementary Table S3.2, S3.3 and S3.4 for constrained factor loadings).

Firstly, we performed several preliminary analyses to make sure latent growth curves analyses could be investigated accordingly. Preliminary analysis consisted of: (a) testing for measurement invariance in perceived motor competence and motor task values for gender and age, and (b) testing for dependence due to the nested structure in the data because children were clustered within school.

Table 3.2 Mean scores perceived motor competence and motor task values per cohort

	Perceived motor competence			Motor task values		
	Fine motor competence *M* (*SD*)	Ball competence *M* (*SD*)	Athletic competence *M* (*SD*)	Fine motor task values *M* (*SD*)	Ball task values *M* (*SD*)	Athletic task values *M* (*SD*)
Cohort I						
KG (*n* = 146)	15.23 (2.39)	9.19 (1.65)	18.20 (1.77)	15.97 (3.08)	8.46 (2.34)	16.20 (2.87)
Grade 1 (*n* = 142)	15.17 (2.15)	9.16 (1.59)	18.13 (1.57)	15.32 (2.54)	8.44 (2.13)	15.36 (2.47)
Grade 2 (*n* = 140)	15.15 (2.34)	9.10 (1.56)	18.16 (1.51)	15.24 (2.72)	8.31 (2.00)	15.17 (2.15)
Cohort II						
Grade 2 (*n* = 146)	15.38 (2.39)	8.74 (1.75)	18.01 (1.62)	16.05 (2.31)	8.16 (1.81)	15.32 (2.01)
Grade 3 (*n* = 143)	15.50 (2.33)	9.01 (1.49)	17.80 (1.72)	15.89 (2.14)	8.42 (1.81)	15.69 (2.13)
Grade 4 (*n* = 142)	15.38 (2.28)	8.78 (1.38)	17.30 (1.62)	15.63 (2.58)	8.37 (1.67)	15.27 (2.11)

Note. KG = Kindergarten.

Table 3.3 Mean scores perceived motor competence and motor task values for boys and girls

	Perceived motor competence			Motor task values		
	Fine motor competence *M* (*SD*)	Ball competence *M* (*SD*)	Athletic competence *M* (*SD*)	Fine motor task values *M* (*SD*)	Ball task values *M* (*SD*)	Athletic task values *M* (*SD*)
Boys						
KG ($n = 80$)	14.79 (2.34)	9.58 (1.65)	18.13 (1.88)	15.60 (3.24)	9.11 (2.22)	16.35 (3.07)
Grade 1 ($n = 79$)	14.76 (2.15)	9.81 (1.42)	18.34 (1.53)	15.10 (2.76)	8.92 (2.10)	15.30 (2.71)
Grade 2 ($n = 146$)	14.27 (2.22)	9.40 (1.52)	18.05 (1.56)	15.40 (2.77)	8.61 (1.96)	15.29 (2.12)
Grade 3 ($n = 66$)	14.41 (2.30)	9.44 (1.43)	17.48 (1.77)	15.76 (2.29)	8.83 (1.93)	15.68 (2.38)
Grade 4 ($n = 66$)	14.59 (2.33)	9.24 (1.14)	17.20 (1.60)	15.47 (2.79)	8.65 (1.80)	15.24 (2.36)
Girls						
KG ($n = 66$)	15.77 (2.35)	8.73 (1.55)	18.29 (1.64)	16.42 (2.83)	7.67 (2.26)	16.02 (2.62)
Grade 1 ($n = 63$)	15.68 (2.05)	8.35 (1.43)	17.86 (1.60)	15.59 (2.21)	7.84 (2.02)	15.43 (2.15)
Grade 2 ($n = 140$)	16.31 (2.03)	8.41 (1.67)	18.12 (1.57)	15.93 (2.27)	7.84 (1.77)	15.20 (2.04)
Grade 3 ($n = 77$)	16.43 (1.92)	8.65 (1.45)	18.08 (1.64)	16.00 (2.01)	8.06 (1.63)	15.70 (1.91)
Grade 4 ($n = 76$)	16.07 (2.02)	8.38 (1.45)	17.38 (1.64)	15.78 (2.39)	8.13 (1.52)	15.30 (1.88)

Note. KG = Kindergarten.

Table 3.4 Mean scores perceived motor competence and motor task values per grade

	Perceived motor competence			Motor task values		
	Fine motor competence *M* (*SD*)	Ball competence *M* (*SD*)	Athletic competence *M* (*SD*)	Fine motor task values *M* (*SD*)	Ball task values *M* (*SD*)	Athletic task values *M* (*SD*)
MP children						
KG (*n*)	14.38 (2.80) (*16*)	7.50 (0.71) (*2*)	18.00 (2.83) (*2*)	16.25 (2.79) (*16*)	8.50 (0.71) (*2*)	17.00 (4.24) (*2*)
Grade 1 (*n*)	15.13 (2.42) (*16*)	9.00 (2.83) (*2*)	17.50 (0.71) (*2*)	15.38 (3.26) (*16*)	11.00 (1.41) (*2*)	17.50 (2.12) (*2*)
Grade 2 (*n*)	13.81 (2.21) (*31*)	7.50 (0.76) (*8*)	16.50 (0.71) (*2*)	15.19 (2.75) (*31*)	7.88 (1.25) (*8*)	15.00 (1.41) (*2*)
Grade 3 (*n*)	13.80 (2.37) (*15*)	7.83 (1.17) (*6*)	- (-) (*0*)	15.27 (2.55) (*15*)	9.33 (2.16) (*6*)	- (-) (*0*)
Grade 4 (*n*)	13.13 (2.33) (*15*)	7.50 (1.38) (*6*)	- (-) (*0*)	14.47 (3.16) (*15*)	8.67 (1.75) (*6*)	- (-) (*0*)
TD children						
KG (n)	15.44 (2.21) (*126*)	9.26 (1.63) (*140*)	18.24 (1.75) (*140*)	15.90 (3.10) (*126*)	8.44 (2.36) (*140*)	16.12 (2.87) (*140*)
Grade 1 (*n*)	15.17 (2.12) (*126*)	9.16 (1.59) (*140*)	18.14 (1.58) (*140*)	15.31 (2.44) (*126*)	8.41 (2.12) (*140*)	15.33 (2.47) (*140*)
Grade 2 (*n*)	15.44 (2.32) (*252*)	8.95 (1.67) (*275*)	18.12 (1.55) (*281*)	15.71 (2.53) (*252*)	8.25 (1.93) (*275*)	15.26 (2.09) (*281*)
Grade 3 (*n*)	15.70 (2.25) (*128*)	9.07 (1.48) (*137*)	17.80 (1.72) (*143*)	15.96 (2.09) (*128*)	8.38 (1.79) (*137*)	15.69 (2.13) (*143*)
Grade 4 (*n*)	15.65 (2.14) (*127*)	8.84 (1.36) (*137*)	17.30 (1.62) (*142*)	15.77 (2.48) (*127*)	8.36 (1.67) (*137*)	15.27 (2.11) (*142*)

Note. KG = Kindergarten; TD children = typically developing children; MP children = children with motor performance.

Secondly, we conducted a linear growth model (McArdle, 1988; Meredith & Tisak, 1990) on common factors for perceived motor competence and motor task values that assumed that the change in perceived motor competence and motor task values can be modelled with a latent intercept (initial status) and slope (linear change), which can vary across children (the intercept and slope may have variance).

Thirdly, if significant variance on intercept or slope between children was found we added gender and motor performance as a covariate to investigate whether gender and motor performance could explain part of the variance in intercept and slope in perceived motor competence and motor task values. Explained variance (R^2) of the intercept and slope is reported in Table 3.5 and Table 3.6.

Finally, we investigated associations between the change in perceived motor competence and motor task values. Using multigroup models, we tested whether these associations differed across gender and motor performance.

Statistical analyses were performed in M*plus* 7.0, using Bayesian estimation with the default settings in the program. M*plus* provides 95% confidence intervals for parameter estimates, which gives the 95% probability that the population parameter will lie between the lower and upper value of the interval. For more information about Bayesian methods in general see Lynch (2007); for the specific implementation in M*plus*, see Muthén (2010). M*plus* also provides *p* values for parameter estimates, which are related to the confidence intervals. They were evaluated against a significance level of .05.

Results

Preliminary analyses

All tables with the results of the preliminary analyses are reported in Supplementary Table S3.5. We found small violations of measurement invariance across boys and girls on specific items. These violations were not consistent across time points and are not expected to affect the results. With regard to age, we tested invariance in perceived motor competence and motor task values between children in kindergarten and grade 4 as possible age differences were expected to be largest between youngest and oldest children. We found some differences on intercept or factor loading of specific items, mostly in favour of children in kindergarten at the start of the study. However, we do not expect that these small differences will affect the results substantially. Because the children were clustered within schools, it would be desirable to correct for the nested structure in the analysis. However, the option to correct for the multilevel structure is not available with Bayesian estimation in M*plus*. Ignoring nestedness may lead to inflated type I errors (Snijders & Bosker, 1999). Effect on parameter estimates in a factor model are found to be ignorable when the intraclass correlations (ICC) < .15, and the influence on standard errors is very small when ICC < .25 and ignorable when ICC < .05 (Pornprasertmanit, Lee, & Preacher, 2014). The item's ICCs for schools ranged between .00 and .19, and are therefore not expected to influence the results.

The change in perceived motor competence

Perceived fine motor competence and perceived athletic competence declined from kindergarten to grade 4, while perceived ball competence stayed the same. Variance between children was significant for intercept and slope for all domains.

Girls perceived themselves as higher in fine motor competence than boys in kindergarten, while boys perceived themselves as higher in ball competence in kindergarten than girls. Perceived athletic competence was the same in boys and girls in kindergarten. The change in perceived fine motor competence, perceived ball competence, and perceived athletic competence was the same in boys and girls, indicating that gender differences in perceived fine motor competence and perceived ball competence stay relatively the same over time.

Perceived fine motor competence, perceived ball competence, and perceived athletic competence was the same in children with motor problems in the corresponding domain and typically developing children in kindergarten. The change in perceived fine motor competence, perceived ball competence, and perceived athletic competence was also the same in children with motor problems in the corresponding domain and typically developing children (see Table 3.5).

The change in motor task values

Fine motor task values, ball task values, and athletic task values stayed the same from kindergarten to grade 4. Variance between children was significant for intercept and slope in all domains.

Boys valued their ball competence as higher than girls in kindergarten, but valued their fine motor competence and athletic competence the same as girls in kindergarten. The change in fine motor task values, ball task values, and athletic task values was the same in boys and girls.

Table 3.5 Perceived motor competence unstandardized results

	Fine motor competence		Ball competence		Athletic competence	
	Estimate	95% CI	Estimate	95% CI	Estimate	95% CI
Intercept (mean)	.00	–	.00	–	.00	–
Slope (mean)	-.12*	[-.16, -.07]	-.02	[-.05, .01]	-.07*	[-.11, -.05]
Intercept on gender (*b*)	.27*	[.09, .45]	-.29*	[-.42, -.18]	-.02	[-.16, .14]
Slope on gender (*b*)	.07	[-.01, .15]	.02	[-.03, .06]	.02	[-.04, .08]
R^2 intercept by gender	.21	[.02, .68]	.40	[.16, .73]	.01	[.00, .15]
R^2 slope by gender	.07	[.00, .42]	.05	[.00, .56]	.03	[.00, .44]
Intercept on motor performance (*b*)	.22	[-.06, .49]	.36	[-.10, .88]	-.07	[-.07, .64]
Slope on motor performance (*b*)	.09	[-.03, .22]	.01	[-.15, .16]	.28	[-.15, .75]
R^2 intercept by motor performance	.08	[.00, .49]	.05	[.00, .26]	.01	[.00, .09]
R^2 slope by motor performance	.07	[.00, .43]	.03	[.00, .54]	.09	[.00, .68]

Note. CI = confidence interval.
* $p < .05$.

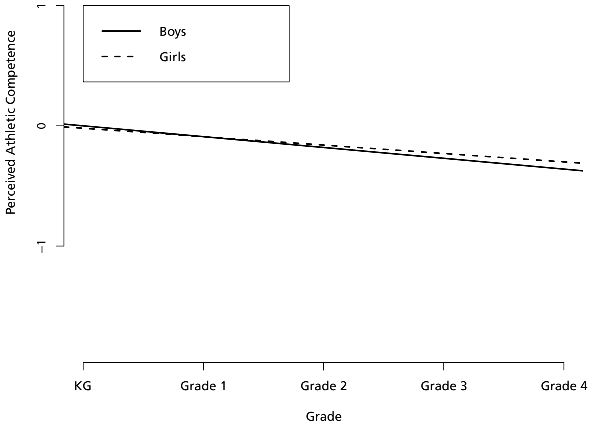


Figure 3.1 Perceived athletic competence: Average growth curve for boys and girls.

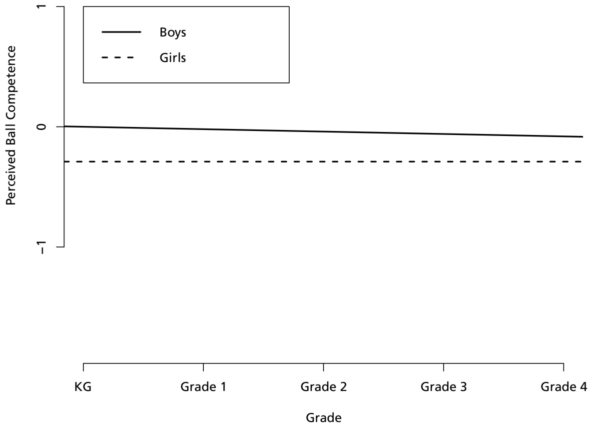


Figure 3.2 Perceived ball competence: Average growth curve for boys and girls.

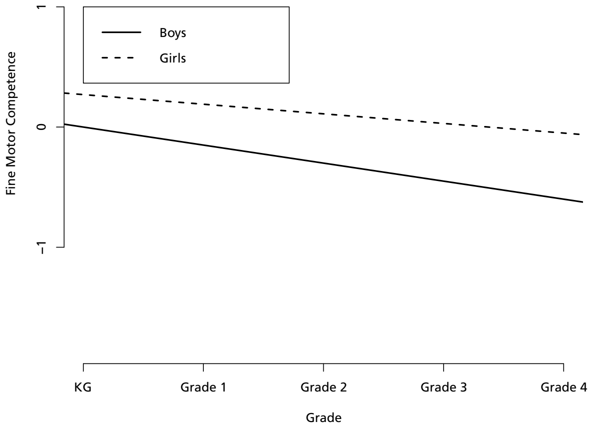


Figure 3.3 Fine motor competence: Average growth curve for boys and girls.

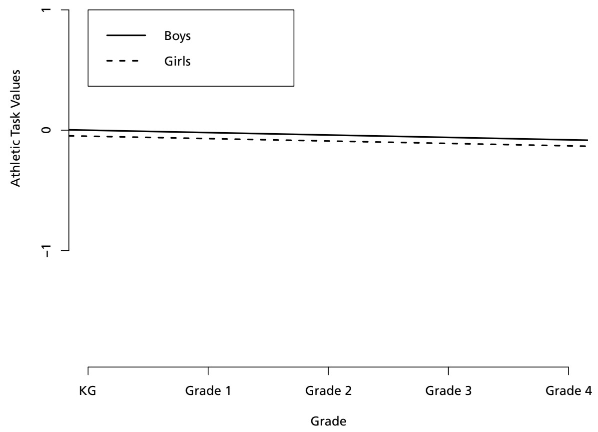


Figure 3.4 Athletic task values: Average growth curve for boys and girls.

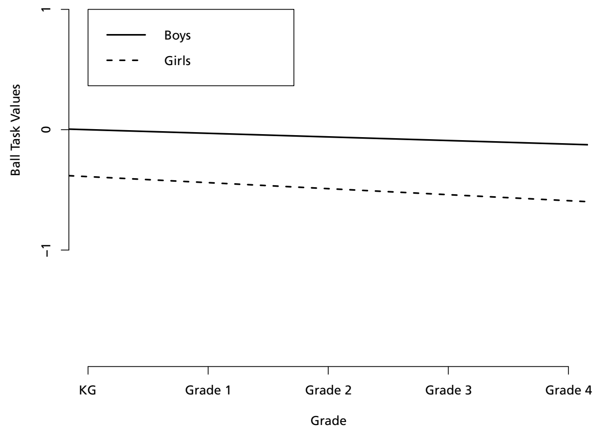


Figure 3.5 Ball task values: Average growth curve for boys and girls.

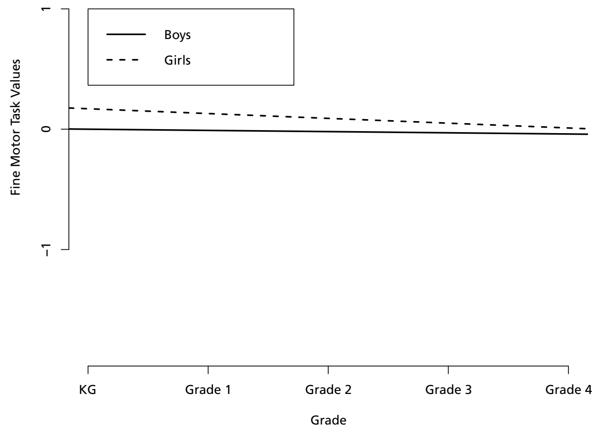


Figure 3.6 Fine motor task values: Average growth curve for boys and girls.

Table 3.6 Motor task values

	Fine motor competence		Ball competence		Athletic competence	
	Estimate	95% CI	Estimate	95% CI	Estimate	95% CI
Intercept (mean)	.00	–	.00	–	.00	–
Slope (mean)	-.02	[-.06, .02]	.00	[-.03, .04]	-.02	[-.05, .01]
Intercept on gender (*b*)	.17	[-.01, .38]	-.39*	[-.58, -.22]	-.05	[-.20, .11]
Slope on gender (*b*)	-.03	[-.11, .05]	.06	[.00, .13]	.00	[-.06, .06]
R^2 intercept by gender	.05	[.00, .23]	.25	[.08, .53]	.02	[.00, .17]
R^2 slope by gender	.01	[.00, .18]	.08	[.00, .47]	.02	[.00, .40]
Intercept on motor performance (*b*)	-.08	[-.37, .20]	.09	[-.52, .76]	-.74	[-1.64, .04]
Slope on motor performance (*b*)	.09	[-.02, .21]	-.08	[-.30, .13]	.39	[-.08, .91]
R^2 intercept by motor performance	.01	[.00, .10]	.01	[.00, .11]	.05	[.01, .27]
R^2 slope by motor performance	.04	[.00, .33]	.02	[.00, .29]	.19	[.01, .81]

Note. CI = confidence interval.
* $p < .05$.

Fine motor task values, ball task values, and athletic task values were the same in children with motor problems in the corresponding domain and typically developing children in kindergarten. The change in fine motor task values, ball task values, and athletic task values was also the same in children with motor problems in the corresponding domain and typically developing children (see Table 3.6).

Associations between perceived motor competence and motor task values

Overall, there were no significant associations between the change in perceptions and task values for fine motor competence[1], ball competence, or athletic competence. Also, associations were not significantly different between boys and girls for fine motor competence, ball competence, and athletic competence, nor significantly different between children with motor problems in the corresponding domain and typically developing children for fine motor competence, ball competence, and athletic competence (see Table 3.7).

Discussion

The change in perceived motor competence

As hypothesized, perceived athletic competence and perceived fine motor competence declined over time. However, perceived ball competence remained the same. We speculate that this unexpected result is due to the activities the children were asked to evaluate themselves on regarding perceived ball competence (i.e., aiming, catching, and throwing). The result of the performance itself is possibly more obvious in ball activities for the child than in fine motor activities and athletic activities. Children are therefore better able to monitor their own progress and, subsequently, more inclined to compare their current performance to their previous performance instead of comparing their performance to their peers. Because actual motor competence improves as children grow older, their aiming, catching, and throwing will improve. So, on the one hand perceptions increase because children are actually getting better in performing the ball activities they are asked to evaluate, while on the other hand perceptions decline over time because of cognitive development. These two counteracting factors might have resulted in a stable perceived ball competence. Future studies should investigate longitudinal associations between perceived ball competence and

1 Associations between perceived fine motor competence and fine motor task values could only be investigated without residual variance covariance between questions.

Table 3.7 Associations between perceived motor competence and motor task values

	Fine motor competence		Ball competence		Athletic competence	
	Estimate	95% CI	Estimate	95% CI	Estimate	95% CI
Association	-.01	[-.01, .02]	.01	[.00, .01]	.00	[.00, .01]
Boys	.02	[-.01, .04]	.03	[.00, .05]	.12*	[.00, .18]
Girls	-.01	[-.04, .01]	.01	[-.01, .02]	.03	[-.01, .04]
cov_{boys} - cov_{girls}	-.03	[-.06, .00]	-.02	[-.05, .01]	-.09	[-.14, .00]
r_{boys} - r_{girls}	-.70	[-1.37, .09]	-.15	[-1.03, .79]	.04	[-1.16, .41]
Children with MP	.00	[-.10, .09]	-.61	[-7.78, 1.91]	7.90	[-11.80, 23.85]
Typ. children	.00	[-.01, .01]	.00	[.00, .01]	.04*	[.01, .25]
cov_{mp} - cov_{typ}	.00	[-.09, .10]	.61	[-1.90, 7.78]	-7.83	[-23.79, 11.82]
$r_{mp} - r_{typ}$	.05	[-1.01, 1.11]	.52	[-.39, 1.48]	0.47	[-0.25, 1.41]

Note. CI = confidence interval; *cov* = covariance; *r* = correlation; MP = motor problems; typ. children = typically developing children.
* $p < .05$.

actual ball competence to better understand the developmental changes in perceived ball competence in children, which has also been suggested by others (e.g., Barnett, Ridgers, & Salmon, 2015).

As hypothesized, girls perceived their fine motor competence as higher from kindergarten to grade 4 than boys, while boys perceived their ball competence as higher from kindergarten to grade 4 than girls. We found no differences in perceived athletic competence, unlike in other studies where boys perceived their athletic competence as higher than girls in elementary school (e.g., Jacobs et al., 2002; Muldoon, 2000). This unexpected result possibly stem from the difference in questionnaires used to investigate perceived athletic competence between studies. The items that we used to investigate perceived athletic competence are less "gender-specific" than the items used in other studies (e.g., Jacobs et al, 2002). For example, we investigated perceptions of hopping, bicycling, swimming, climbing, and running, while other studies investigated a more global construct of athletic abilities (e.g., how do you perceive yourself in sports).

We found no differences in self-perceptions between children with motor problems and typically developing children. We argue that this unexpected result is due to the small number of children with motor problems in this study. Because the stability of motor performance in children is low (Roze et al., 2010), we decided to categorize children as having motor problems only if they scored ≤ 16^{th} percentile on at least two (out of the three) measurement occasions to make sure motor problems were persistent over time. This resulted in a small number of children who experienced motor problems in their manual dexterity ($n = 31$), ball skills ($n = 8$), and balance ($n = 2$). If we categorized children as having motor problems when they scored ≤ 16^{th} percentile only on one occasion, 82 children experienced motor problems in their manual dexterity, 42 children experienced motor problems in their ball skills, and 13 children experienced motor problems in their balance. However, the outcome of identical statistical analyses as reported here still showed no differences between children with motor problems and typically developing children, with the exception of perceived fine motor competence whereby children with motor problems scored lower than typically developing children in kindergarten. This difference remained the same over time. We expect that children receive, as early as kindergarten, more feedback from parents and teachers about their fine motor competence (e.g., crafts, handwriting) than about their ball competence and athletic competence. Also, fine motor competence lends itself well for comparison between (younger) children. We therefore argue that children who experience problems in their fine motor competence also perceive their fine motor competence as lower than typically developing children from kindergarten to grade 4.

The change in motor task values

Task values stayed the same over time. Boys valued their ball competence as higher than girls from kindergarten to grade 4, while task values of fine motor competence and athletic competence were the same in boys and girls over time. These results are not in agreement with Jacobs et al. (2002), who found large differences in the change in athletic task values between boys and girls during elementary school. We argue that the questions asked to investigate fine motor task values and athletic task values consist of activities that are essential for daily life (e.g., swimming, handwriting, tying shoelaces). Although we found a decline in self-perceptions of fine motor competence and athletic competence, children are aware that these activities are important in daily life, equally so for boys and girls. Interestingly, we found the same gender differences and developmental changes in perceived ball competence and ball task values. Barnett, Ridgers, and Salmon (2015) also found that girls between 4 and 8 years of age had a lower perceived ball competence than boys. We extended their findings by investigating these gender differences longitudinally and in ball task values.

As hypothesized, we found no differences in task values between children with motor problems and typically developing children. However, this result should be interpreted with caution because of the small number of children with motor problems.

Associations between the change in perceived motor competence and motor task values

We found, unexpectedly, no associations between self-perceptions and task values. However, we argue, as mentioned before, that children are aware that the activities asked to investigate perceived motor competence and motor task values are important for daily life, equally so for boys and girls. Self-perceptions of fine motor competence and athletic competence declined at the same rate in boys and girls, while task values remained stable in boys in girls. From a statistical perspective, this results in a non-significant difference in associations between boys and girls.

As mentioned before, the small number of children with motor problems is most likely the primary reason for not finding differences in perceived motor competence and motor task values between children with motor problems and typically developing children. This also results in a non-significant difference in associations between children with motor problems and typically developing children.

Weaknesses and strengths

Several limitations have to be recognized. First, we have limited psychometric knowledge about the How Am I Doing questionnaire. To evaluate this limitation we investigated factor loadings of the items on the corresponding latent variable. Factor loadings of perceived fine motor competence and perceived athletic competence were generally low, but statistically significant, indicating that the validity and reliability of the observed scores was questionable. Factor loadings of perceived ball competence and task values were not high, but substantial, and statistically significant. Although the reliability of the used measures was not satisfactory according to Cronbach's alpha, we note that the growth models were fitted on the common factors, and not on the observed scores. The common factor represents the true-score part of the observed variables. Therefore, although the measurement error in the observed indicators was large, the measurement errors are accounted for by the latent variable model (Bollen, 1989). The low reliability of the measurements indicate that the observed scores of this questionnaire should not be used to make predictions or decisions at the individual level. SEM-analysis however, can still provide unbiased estimates of population parameters (DeShon, 1998). Moreover, the measurement invariance analysis showed that measurement parameters were generally equal across age and gender, so that the change in the latent variables can be evaluated without age or gender bias (Widaman, Ferrer, & Conger, 2010). Secondly, only a small number of children were categorized as having motor problems on the subsets ball skills and balance of the MABC-2. Future research should also include children with motor problems who are clinically referred (e.g., developmental coordination disorder (DCD)) to increase the number of children with motor problems to obtain a better understanding about the influence of motor problems on self-perceptions and task values. Thirdly, we did not specifically test children for any neurodevelopmental disorders (e.g., DCD, cerebral palsy (CP)) that might have been associated with motor difficulties, and so this may have affected the results. Finally, the order in which children performed the MABC-2 and the How Am I Doing Questionnaire was at random. Children were assessed on two separate occasions (mostly on the same day or within one or two days) because we argued that the length of the total assessment would have a negative influence on the child's concentration and, therefore, performance. In doing so, children might be aware about their motor performance if the MABC-2 was administered first, having a possible influence on their perceived motor competence. However, we argue that this impact is negligible because self-perceptions about specific activities are asked in the How Am I Doing questionnaire, which are not assessed with the MABC-2.

In terms of strengths, our longitudinal design allowed us to investigate developmental changes in, and associations between, self-perceptions and task values. We investigated changes in self-perceptions and task values on a latent level. By fitting the growth model on factors instead of scale scores, measurement error at the item level is taken into account by the measurement model (e.g., Preacher, Wichman, MacCallum, & Briggs, 2008). Also, this is the first study that distinguished between self-perceptions and task values of fine motor competence, ball competence, and athletic competence in elementary school children. In doing so, more specific insight is provided about the change in, and associations between, self-perceptions and task values.

To conclude, our study expands the knowledge on self-perceptions and task values in fine motor competence, ball competence, and athletic competence in elementary school children. We found that the change in self-perceptions and task values, and differences between boys and girls, was domain specific. This information can be used to help educators understand why, and why not, children participate in daily activities that require motor competence. Educators should address specific self-perceptions to enhance participation into the corresponding motor activities in children between kindergarten and grade 4, and differences in self-perceptions and task values between boys and girls should be taken into account. Future research should, as suggested by the Expectancy-Value model, investigate how self-perceptions and task values influence daily activities in the corresponding domain, taking developmental and gender differences into account.

References

Baerg, S., Cairney, J., Hay, J., Rempel, L., Mahlberg, N., & Faught, B. E. (2011). Evaluating physical activity using accelerometry in children at risk of developmental coordination disorder in the presence of attention deficit hyperactivity disorder. *Research in Developmental Disabilities*, *32*, 1343-1350.

Bollen, K. A. (1989). *Structural equations with latent variables*. New York: Wiley

Barnett, L. M., Ridgers, N. D., & Salmon, J. (2015). Associations between young children's perceived and actual ball skill competence and physical activity. *Journal of Science and Medicine in Sport*, *18*, 167-171. doi: 10.1016/j.jsams.2014.03.001

Brown, T., & Lalor, A. (2009). The movement assessment battery for children - second edition (MABC-2): A review and critique. *Physical & Occupational Therapy in Pediatrics*, *29*, 86-103. doi: 10.1080/01942630802574908

Cairney, J., Hay, J. A., Faught, B. E., Wade, T. J., Corna, L., & Flouris, A. (2005). Developmental coordination disorder, generalized self-efficacy toward physical activity, and participation in organized and free play activities. *The Journal of Pediatrics*, *147*, 515-520. doi: 10.1016/j.jpeds.2005.05.013

Calame, E., Reinders, H., Smits-Engelsman, B. C. M., Schoemaker, M. M., Volman, M. J. M., & De Kloet, A. (2009). *Hoe ik vind dat ik het doe vragenlijst: Vragenlijst motorische competentiebeleving (How am I doing questionnaire: A questionnaire to investigate perceived motor competence).* Unpublished manuscript.

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

DeShon, R. P. (1998). A cautionary note on measurement error corrections in structural equation models. *Psychological Methods*, *3*, 412-423. doi: 10.1037/1082-989X.3.4.412

Duncan, S. C., Duncan, T. E., Strycker, L. A., & Chaumeton, N. R. (2007). A cohort-sequential latent growth model of physical activity from ages 12 to 17 years. *Annals of Behavioral Medicine*, *33*, 80-89. doi: 10.1207/s15324796abm3301_9

Eccles, J. S., Adler, T. F., Futterman, R., Goff, S. B., Kaczala, C. M., Meece, J. L., & Midgley, C. (1983). Expectancies, values, and academic behaviors. In J. T. Spence (Ed.), *Achievement and achievement motivation* (pp. 77-146). San Fransico, CA: W.H. Freeman.

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

Harter, S. (2006). The self. In N. Eisenberg, W. Damon, & R. M. Lerner (Eds.), *Handbook of Child Psychology, 6th Edition, Volume 3: Social, Emotional, and Personality Development* (pp. 505-570). Hoboken, NJ: John Wiley & Sons.

Henderson, S. E., Sugden, D. A., & Barnett, A. (2007). *Movement assessment battery for children - second edition [Movement ABC-2]*. London: The Psychological Corporation.

Jacobs, J. E., Lanza, S., Osgood, D. W., Eccles, J. S., & Wigfield, A. (2002). Changes in children's self-competence and values: Gender and domain differences across grades one through twelve. *Child Development*, *73*, 509-527. doi: 10.1111/1467-8624.00421

Junaid, K. A., & Fellowes, S. (2006). Gender differences in the attainment of motor skills on the movement assessment battery for children. *Physical & Occupational Therapy in Pediatrics*, *26*, 5-12. doi: 10.1300/j006v26n01_02

Lynch S. (2007). *Introduction to applied Bayesian statistics and estimation for social scientists*. New York: Springer.

Marsh, H. W., & Craven, R. G. (1997). Academic self-concept: Beyond the dustbowl. In G. Phye (Ed.), *Handbook of classroom assessment: Learning, achievement and adjustment*. San Diego, CA: Academic Press.

McArdle, J. J. (1988). Dynamic but structural equation modeling of repeated measures data. In J. R. Nesselroade & R. B. Cattell (Eds.), *Handbook of multivariate experimental psychology: Perspectives on individual differences* (pp. 561-614). New York, NY: Plenum Press.

McArdle, J. J. (2009). Latent variable modeling of differences and changes with longitudinal data. *Annual Review of Psychology*, *60*, 577-605. doi: 10.1146/annurev.psych.60.110707.163612

Meredith, W., & Tisak, J. (1990). Latent curve analysis. *Psychometrika*, *55*, 107-122. doi: 10.1007/bf02294746

Muldoon, O. T. (2000). Social group membership and self-perceptions in Northern Irish children: A longitudinal study. *British Journal of Developmental Psychology*, *18*, 65-80. doi: 10.1348/026151000165571

Muthén, B. (2010). *Bayesian analysis in Mplus: A brief introduction*. Unpublished manuscript. Retrieved from www.statmodel.com

Oort, F. J. (2001). Three-mode models for multivariate longitudinal data. *The British Journal of Mathematical and Statistical Psychology*, *54*, 49-78. doi: 10.1348/000711001159429

Piek, J. P., Baynam, G. B., & Barrett, N. C. (2006). The relationship between fine and gross motor ability, self-perceptions and self-worth in children and adolescents. *Human Movement Science*, *25*, 65-75. doi: 10.1016/j.humov.2005.10.011

Pless, M., Carlsson, M., Sundelin, C., & Persson, K. (2001). Pre-school children with developmental co-ordination disorder: Self-perceived competence and group motor skill intervention. *Acta Paediatrica*, *90*, 532-538. doi: 10.1080/080352501750197674

Pornprasertmanit, S., Lee, J., & Preacher, K. J. (2014). Ignoring clustering in confirmatory factor analysis: Some consequences for model fit and standardized parameter estimates. *Multivariate Behavioral Research*, *49*, 518-543. doi:10.1080/00273171.2014.933762

Poulsen, A. A., Ziviani, J. M., & Cuskelly, M. (2006). General self-concept and life satisfaction for boys with differing levels of physical coordination: The role of goal orientations and leisure participation. *Human Movement Science*, *25*, 839-860. doi: 10.1016/j.humov.2006.05.003

Poulsen, A. A., Ziviani, J. M., & Cuskelly, M. (2008). Leisure time physical activity energy expenditure in boys with developmental coordination disorder: The role of peer relations self-concept perceptions. *OTJR: Occupation, Participation and Health*, *28*, 30-39. doi: 10.3928/15394492-20080101-05

Preacher, K. J., Wichman, A. L., MacCallum, R. C., & Briggs, N. E. (2008). *Latent Growth Curve Modeling*. Thousand Oaks, CA: SAGA Publications, Inc.

Roze, E., Meijer, L., Van Braeckel, K. N., Ruiter, S. A., Bruggink, J. L., & Bos, A. F. (2010). Developmental trajectories from birth to school age in healthy term-born children. *Pediatrics*, *126*, e1134-1142. doi: 10.1542/peds.2010-0698

Schaie, K. W. (1965). A general model for the study of developmental problems. *Psychological Bulletin*, *64*, 92-107. doi: 10.1037/h0022371

Snijders, T. A. B., & Bosker, R. J. (1999). *Multilevel analysis: An introduction to basic and advanced multilevel modeling*. Sage, CA: Thousand Oaks.

Volman, M. J. M. (2009, June). *"How Am I Doing", A new pictorial scale for perceived athletic competence for children aged 6 to 12 years*. Poster session presented at the VIII International Conference on DCD, Baltimore, USA.

Widaman, K. F., Ferrer, E., & Conger, R. D. (2010). Factorial invariance within longitudinal structural equation models: Measuring the same construct across time. *Child Development Perspectives*, *4*, 10-18. doi: 10.1111/j.1750-8606.2009.00110.x

Wigfield, A., Harold, R. D., Freedman-Doan, C., Eccles, J. S., Yoon, K. S., Arbreton, A. J., & Blumfield, P. C. (1997). Change in children's competence beliefs and subjective task values across the primary school years: A 3-year study. *Journal of Educational Psychology*, *89*, 451-469. doi: 10.1037/0022-0663.89.3.451

Supplementary material

Supplementary Table S3.1 Cronbach alpha per subscale per grade

	PFMC	PBC	PAC	FMTV	BTV	ATV
KG	.193	.238	.320	.616	.238	.597
Grade 1	.147	.345	.327	.475	.345	.500
Grade 2	.367	.488	.364	.600	.488	.453
Grade 3	.430	.515	.519	.488	.515	.553
Grade 4	.518	.588	.415	.717	.588	.635

Note. KG = kindergarten; PFMC = perceived fine motor competence; PBC = perceived ball competence; PAC = perceived athletic competence; FMTV = Fine motor task values; BTV = ball task values; ATV = athletic task values.

Supplementary Table S3.2 Factor loadings for perceived athletic competence and athletic task values per grade (*n* = 292)

	Perceived athletic competence		Athletic task values	
	Constrained estimation[a] (standardized)	95% CI	Constrained estimation[a] (standardized)	95% CI
Athletic KG				
Hopping	.38	[.24, .52]	.39	[.27, .52]
Bicycle	.20	[.11, .31]	.43	[.32, .55]
Swimming	.18	[.09, .30]	.22	[.13, .31]
Climbing	.32	[.19, .46]	.58	[.45, .71]
Running	.39	[.25, .55]	.60	[.48, .72]
Athletic G1				
Hopping	.32	[.20, .46]	.43	[.32, .55]
Bicycle	.30	[.17, .44]	.39	[.26, .53]
Swimming	.19	[.10, .31]	.25	[.15, .36]
Climbing	.25	[.15, .38]	.55	[.42, .68]
Running	.29	[.18, .43]	.51	[.39, .64]
Athletic G2				
Hopping	.38	[.26, .50]	.37	[.27, .46]
Bicycle	.28	[.18, .40]	.30	[.22, .39]
Swimming	.26	[.15, .38]	.25	[.15, .35]
Climbing	.31	[.20, .44]	.47	[.37, .58]
Running	.33	[.22, .46]	.45	[.35, .56]
Athletic G3				
Hopping	.44	[.32, .58]	.38	[.28, .48]
Bicycle	.37	[.21, .55]	.42	[.30, .55]
Swimming	.31	[.17, .47]	.29	[.17, .41]
Climbing	.40	[.26, .54]	.56	[.43, .68]
Running	.37	[.26, .49]	.54	[.41, .66]
Athletic G4				
Hopping	.44	[.31, .57]	.49	[.38, .61]
Bicycle	.33	[.19, .47]	.41	[.29, .54]
Swimming	.26	[.14, .40]	.24	[.14, .36]
Climbing	.35	[.21, .51]	.65	[.52, .76]
Running	.41	[.25, .58]	.59	[.45, .72]

Note. CI = confidence interval; hopping = hopping; climbing = climbing; running = running; bicycle = riding a bicycle; swimming = swimming; KG = Kindergarten; G = grade.
[a] Factor loadings are equal for every year in the unstandardized model.

Supplementary Table S3.3 Factor loadings for perceived ball competence and ball task values per grade (*n* = 292)

	Perceived ball competence		Ball task values	
	Constrained estimation[a] (standardized)	95% CI	Constrained estimation[a] (standardized)	95% CI
Ball KG				
Catch	.33	[.22, .47]	.55	[.45, .65]
Throw	.39	[.26, .54]	.69	[.57, .81]
Aim	.40	[.26, .56]	.56	[.46, .66]
Ball G1				
Catch	.37	[.26, .50]	.62	[.50, .73]
Throw	.41	[.28, .55]	.67	[.56, .78]
Aim	.44	[.29, .61]	.55	[.45, .65]
Ball G2				
Catch	.41	[.31, .53]	.58	[.50, .66]
Throw	.47	[.34, .60]	.68	[.60, .76]
Aim	.49	[.35, .63]	.61	[.52, .70]
Ball G3				
Catch	.45	[.33, .57]	.58	[.48, .68]
Throw	.49	[.35, .64]	.73	[.62, .83]
Aim	.50	[.36, .65]	.66	[.56, .76]
Ball G4				
Catch	.54	[.41, .67]	.66	[.56, .75]
Throw	.53	[.37, .69]	.76	[.66, .85]
Aim	.63	[.47, .78]	.67	[.56, .77]

Note. CI = confidence interval; catch = catching a ball; throw = throwing a ball; score = scoring a ball; KG = Kindergarten; G = grade.
[a] Factor loadings are equal for every year in the unstandardized model.

Supplementary Table S3.4 Factor loadings for perceived fine motor competence and fine motor task values per grade (*n* = 292)

	Perceived fine motor competence		Fine motor task values	
	Constrained estimation[a] (standardized)	95% CI	Constrained estimation[a] (standardized)	95% CI
Fine motor KG				
Scissors	.61	[.32, .85]	.52	[.40, .63]
Shoelaces	-.04	[-.41, .04]	.46	[.36, .57]
Eating	.22	[.11, .36]	.55	[.42, .68]
Handwrite	.21	[.09, .33]	.39	[.28, .51]
Buttoning	.17	[.00, .28]	.42	[.31, .53]
Fine motor G1				
Scissors	.47	[.23, .68]	.41	[.31, .52]
Shoelaces	-.04	[-.38, .05]	.39	[.28, .51]
Eating	.21	[.10, .34]	.40	[.29, .52]
Handwrite	.27	[.11, .42]	.43	[.31, .56]
Buttoning	.18	[.00, .32]	.37	[.27, .49]
Fine motor G2				
Scissors	.65	[.23, .84]	.49	[.40, .58]
Shoelaces	-.06	[-.37, .07]	.53	[.43, .63]
Eating	.24	[.10, .35]	.46	[.36, .56]
Handwrite	.30	[.09, .43]	.46	[.37, .56]
Buttoning	.21	[.00, .33]	.43	[.34, .53]
Fine motor G3				
Scissors	.57	[.11, .77]	.42	[.32, .52]
Shoelaces	-.06	[-.26, .08]	.52	[.40, .65]
Eating	.23	[.06, .36]	.37	[.28, .48]
Handwrite	.26	[.04, .42]	.37	[.27, .48]
Buttoning	.22	[.00, .36]	.40	[.29, .52]
Fine motor G4				
Scissors	.67	[.12, .88]	.62	[.52, .72]
Shoelaces	-.08	[-.33, .10]	.68	[.55, .79]
Eating	.28	[.07, .44]	.55	[.44, .66]
Handwrite	.32	[.05, .48]	.48	[.37, .60]
Buttoning	.26	[.00, .41]	.53	[.42, .63]

Note. CI = confidence interval; scissors = cutting with scissors; shoelaces = tying shoelaces; eating = eating with knife and fork; handwrite = handwriting; buttoning = buttoning; KG = kindergarten; G = grade.
[a] Factor loadings are equal for every year in the unstandardized model.

Supplementary Table S3.5 Degrees of freedom, χ^2, lower and upper bound of the RMSEA and conclusion about bias for model with strong factorial invariance across gender in each grade

	df	χ^2	Lo RMSEA	Hi RMSEA	MI
PFC					
KG	18	20.85	.000	.169	No
Grade 1	18	44.26	.157	.212	No
Grade 2	18	24.43	.000	.189	No
Grade 3	Error[1]				
Grade 4	18	8.75	.000	.000	No
PBC					
KG	4	3.23	.000	.161	No
Grade 1	4	7.07	.000	.227	No
Grade 2	4	8.40	.000	.172	Yes[2]
Grade 3	4	1.11	.000	.080	No
Grade 4	4	2.60	.000	.147	No
PAC					
KG	18	43.51	.087	.193	No
Grade 1	18	14.49	.000	.083	No
Grade 2	18	39.35	.052	.130	Yes[3]
Grade 3	18	35.07	.056	.172	Yes[4]
Grade 4	18	45.94	.096	.202	Yes[5]

Note. KG = kindergarten; PFC = perceived fine motor competence; PBC = perceived ball competence; PAC = perceived athletic competence; MI = modification index for factor loading or intercept. MIs for PFC and PAC where tested against $\chi^2 = 7.88$, which is the critical value associated with an Bonferroni corrected alpha-level of .05 / 10, where 10 is the number of factor loadings and intercepts under consideration. MI for PBC was tested against $\chi^2 = 6.96$, which is the critical value associated with Bonferroni corrected alpha-level of .05 / 6, where 6 is the number of factor loadings and intercepts under consideration.

[1] item "buttoning" had no variance; [2] intercept for "catch" was higher for girls; [3] intercept for "running" was higher for boys; [4, 5] intercept for "hopping" was higher for girls.

PART II

Chapter 4

The effect of an integrated behavioral and motor intervention in children with probable developmental coordination disorder

Johannes J. Noordstar
Janjaap van der Net
Lia Voerman
Paul J.M. Helders
Marian J. Jongmans

Research in Developmental Disabilities, resubmitted

Acknowledgement of authors' contributions:
J.N, J.V.N, P.H., and M.J designed the study; L.V. trained the therapists; J.N. gathered the data and performed the data-analysis; J.N. wrote the paper; J.V.N, L.V., P.H., and M.J. edited the paper.

Abstract

Background and aims Children with probable DCD (pDCD) have lower self-perceptions and are less physically active than typically developing children. The aim of this quasi-experimental study was to investigate whether an integrated behavioral and motor intervention affects pDCD children's motor performance, self-perceptions, and physical activity compared with a motor intervention only.

Methods and procedures The intervention group consisted of 20 children and the care-as-usual group consisted of 11 children, all aged 7–10 years. The behavioral component of the intervention focused primarily on providing positive, specific, and progress feedback to enhance self-perceptions. We assessed children at baseline, after 12 treatment sessions (trial end-point), and at 3-month follow-up.

Outcomes and results Mixed linear models revealed no differences between the intervention and the care-as-usual group on any of the outcome measures. Children improved their motor performance and increased their perceived athletic competence, global self-esteem, and perceived motor competence after 12 treatment sessions. This improvement was maintained at 3-month follow-up. Motor task values and physical activity remained unchanged for all children.

Conclusions and implications An integrated behavioral and motor intervention is as effective as care-as-usual in children with pDCD. Future research should focus on improving physical activity in children with pDCD.

Introduction

Children with developmental coordination disorder (DCD) have trouble mastering and performing motor activities. This impairment significantly interferes with activities in daily life and/or academic achievement and is not due to a general medical condition (American Psychiatric Association [DSM-V], 2013). If all criteria for diagnosing children with DCD are described, but one or more of the criteria is not evaluated, children are categorized as having probable DCD (pDCD) (Smits-Engelsman, Schoemaker, Delabastita, Hoskens, & Geuze, 2015). This distinction between children with DCD and pDCD was made in recent studies (e.g., Jelsma, Ferguson, Smits-Engelsman, & Geuze, 2015), but children with pDCD were categorized as having DCD in older studies (e.g., Wu, Lin, Li, Tsai, & Cairney, 2010). We used the term pDCD throughout this article for clarity and because the children that we included in this study were categorized as having pDCD. The prevalence of pDCD is estimated at around 5-6% in school-aged children, where boys are overrepresented compared with girls (Blank, Smits-Engelsman, Polatajko, & Wilson, 2012). Also, large differences in motor problems exist. Some children with pDCD experience fine motor problems, while other children experience gross motor problems (e.g., Noordstar et al., 2014; Vaivre-Douret et al., 2011). Children with pDCD participate less in motor activities in daily life (e.g., physical activity) than typically developing children (Cairney et al., 2005; Cairney, Hay, Veldhuizen, Missiuna, & Faught, 2010; Noordstar et al., 2014).

Children with pDCD are often referred to a pediatric physical therapist (or pediatric occupational therapist) to learn to master motor activities (e.g., riding a bike, skipping rope). The motor interventions used can generally be divided into process-oriented interventions and task-oriented interventions (Zwicker, Missiuna, Harris, & Boyd, 2012). Process-oriented motor interventions focus on improving the underlying motor processes and body functions in order to master motor activities, while task-oriented motor interventions focus on the specific motor activity the child experiences problems in (Smits-Engelsman et al., 2013). There is little evidence that process-oriented motor interventions improve motor performance, but the results of the task-oriented motor interventions are encouraging (e.g., Miller, Polatajko, Missiuna, Mandich, & Mcnab, 2001; Smits-Engelsman et al., 2013; Thornton et al., 2016). More traditional pediatric physical therapy (i.e., care-as-usual) combines underlying process-oriented approaches with direct skill training (e.g., task-oriented approach) (Smits-Engelsman et al., 2013).

Children need an extensive number of (gross) motor activities to participate in physical activity. Motor interventions focus mainly on mastering these motor activities (*can do*), but it is unclear whether any improvement in motor activities results in more participation in physical activity (*does do*). Participation in physical activity can be defined as the frequency of attendance in physical activities (Imms et al., 2015). Motivation theorists argue that competence beliefs and task values influence motivation for achievement behavior (i.e., physical activity) (e.g., Eccles et al., 1983; Harter, 1981). Stodden et al. (2008) proposed a conceptual model in which competence beliefs (e.g., perceived athletic competence) mediate the relationship between motor performance and physical activity. Perceived athletic competence is described as the way children perceive their sports ability and athletic performance (Harter, 1982). Children with higher levels of motor performance and perceived athletic competence are likely to be more involved in physical activity (Stodden et al., 2008).

Children with pDCD have a lower perceived athletic competence than typically developing children at 7 years old (e.g., Poulsen, Ziviani, & Cuskelly, 2008). Cairney et al. (2005) argued that differences in physical activity between children with pDCD and their typically developing peers are mainly due to the difference in perceived athletic competence. They found that perceived athletic competence mediated the difference in physical activity between children with pDCD and their typically developing peers. The authors argued that perceived athletic competence should be a target for interventions in children with pDCD to increase physical activity. However, to date, we have found no studies that investigated the effect of an intervention that aimed to increase perceived athletic competence (behavioral component) and master new motor activities (motor component) to increase physical activity in children with pDCD.

Feedback has a powerful influence on learning (e.g., motor performance), competence beliefs (e.g., perceived athletic competence), and achievement behavior (e.g., physical activity) (Duijnhouwer, 2010; Hattie & Timperly, 2007). Feedback is commonly conceptualized as "… information provided by an external agent regarding some aspect(s) of the learner's task performance, intended to modify the learner's cognition, motivation, and/or behavior for the purpose of improving performance." (Duijnhouwer, 2010, p. 16). However, there are multiple types of feedback, and effect sizes show considerable variability, indicating that some types of feedback are more powerful than others (Hattie, 2012). Feedback is most effective when it is specific, goal-related, and not too elaborated (Hattie & Timperly, 2007; Kluger & DeNisi, 1996; Shute, 2008). It is therefore important to set specific goals in order to provide effective feedback. Feedback is also most effective when it provides information on correct (*positive*) rather than incorrect (*negative*) responses (Losada & Heaphy, 2004). With regard to motor learning specifically, feedback is often differentiated in intrinsic feedback and extrinsic feedback. Intrinsic feedback is the sensory information that arises as a natural consequence of producing a movement, while extrinsic feedback is information that is provided to the child by some outside source (e.g., pediatric physical therapist) (Schmidt & Wrisberg, 2000). Children with pDCD experience problems with their intrinsic feedback (i.e., sensory-perceptual function) (see for review Wilson, Ruddock, Smits-Engelsman, Polatajko, & Blank, 2013), resulting in less "learning by experience". Pediatric physical therapists provide extrinsic feedback during treatment sessions to improve the child's motor performance. This extrinsic feedback is further differentiated in two categories: (a) Knowledge of results, and (b) knowledge of performance. Knowledge of results refers to information that tells the child something about the success of his action (e.g., you caught that ball 7 out of 10 times). Knowledge of performance provides the child with information about the pattern of his movements (e.g., you did not bend your knees before you made the jump) (Schmidt & Wrisberg, 2000). Furthermore, the feedback frequency also influences motor learning (e.g., Sullivan, Kantak, & Burtner, 2008).

Voerman, Korthagen, Meijer, and Simons (2014) made another distinction between effective types of feedback: *progress feedback* and *discrepancy feedback*. Progress feedback focuses on the improvement between the initial and current level of performance, while discrepancy feedback focuses on (closing) the gap between the current and desired level of performance (e.g., Kluger & DeNisi, 1996). They stated that progress feedback helps the student believe in his or her capacity to learn, and will subsequently stimulate performance (Voerman, Korthagen, Meijer, & Simons, 2014). Moreover, Duijnhouwer (2010) stated that progress feedback improves competence beliefs (e.g., perceived athletic competence) because it suggests that individuals are able to improve their performance.

However, most studies standardized their feedback to investigate the effect on motor performance, making generalization to daily practice questionable (e.g., Chiviacowsky & Wulf, 2007). We therefore investigated if training a group of pediatric physical therapists in providing specific, (mainly) positive, goal-specific, progress feedback would affect motor performance, self-perceptions, and physical activity in children with pDCD. Ultimately, the results of our study might be incorporated into the daily practice of pediatric physical therapists who treat children with pDCD.

Specifically, the aim of this quasi-experimental study was to investigate the effect of an integrated behavioral and motor intervention (intervention group) in children with pDCD aged 7–10 years compared with a motor intervention (care-as-usual group) only. We investigated the effect after 12 treatment sessions (trial end-point), and after 3 months of no intervention (follow-up). Primary outcome measures were motor performance, motor difficulties, perceived athletic competence, and perceived motor competence. Secondary outcome measures were motor task values, total physical activity, leisure physical activity, and global self-esteem.

We also benchmarked the results of the psychological and physical activity outcome measures to a group of typically developing children aged 7–10 years. In doing so, we investigated if differences between the children with pDCD and the typically developing children decreased after 12 treatment sessions and at the 3-month follow-up.

We hypothesized that children with pDCD in the intervention group would improve more than children with pDCD in the care-as-usual group on both primary and secondary outcome measures directly after the intervention. We also hypothesized that this improvement would be maintained in the intervention group at the 3-month follow-up, but that the improvement would diminish in the care-as-usual group. Finally, as a result of the hypothesized improvement in children with pDCD, we hypothesized that differences on outcome measures between children with pDCD and typically developing children would decrease, with smaller differences between children with pDCD in the intervention group and typically developing children than between children with pDCD in the care-as-usual group and typically developing children.

Methods

Study design

We performed a quasi-experimental study with a between subject design. Also, to benchmark the effect of the intervention, we used a control group of typically developing children who did not receive an intervention and were measured on one occasion. The Medical Research Ethics Committee of the University Medical Center Utrecht approved this study. All families gave written informed consent for their child's participation.

Participants

Pediatric physical therapists[1] included children from October 2013 to April 2015 and administered the integrated behavioral and motor intervention designed especially for this study. Other pediatric physical therapists included children from September 2013 to April 2015 and administered a motor intervention to the care-as-usual group. Inclusion

1 In the Netherlands, treatment of children with pDCD is performed by pediatric physical therapists, pediatric occupational therapists, and pediatric exercise therapists (Cesar / Mensendieck). Treatment of children with pDCD is comparable, although small differences may exist, and focus on improving the child's motor performance. The therapists that participated in this study are schooled as pediatric exercise therapists.

criteria were: (a) children referred to pediatric physical therapy by a general practitioner or school medical officer, (b) a total score ≤ 16th percentile on the MABC-2 (criterion A), (c) an indication of DCD or suspected DCD on the Developmental Coordination Disorder Questionnaire 2007 (DCD-Q) as experienced by parents (criterion B), (d) a mean score below the advised number of daily steps for children (boys < 15000; girls < 12000) on a pedometer (Yamax CW700), (e) aged between 7 and 10 years old (criterion C), and (f) no known neurological disorder causing motor problems (e.g., Cerebral Palsy, Spina Bifida) (criterion D). Children were excluded when their total score ≤ 16th percentile on the MABC-2 was the result of a low score on the subscale manual dexterity only since no associations between manual dexterity, perceived athletic competence, and physical activity were expected (Piek, Baynam, & Barret, 2006; Noordstar et al., 2014).

The control group of typically developing children consisted of a subsample of children who participated in the Move Along study, a longitudinal study that investigated the development of, and associations between, motor performance, perceived competence, global self-esteem, and physical activity in children in elementary school (see Noordstar, Van der Net, Jak, Helders, & Jongmans, 2016a, 2016b). We used data from the second year (2012) of this longitudinal study, when the children were in grade 3 of elementary school (n = 143; age 8.38; SD = .52; 66 boys). However, the Yamax CW700 Digiwalker Pedometer was only administered in the final year of the longitudinal study (2013), when children were either in grade 2 or grade 4 of elementary school (n = 94; age 8.31; SD = 1.11; 41 boys), and was used to benchmark total physical activity.

Allocation and training of pediatric physical therapists

A total of 30 pediatric physical therapists participated in this study. All pediatric physical therapists received their specialist training at the University of Applied Sciences Utrecht. Years of experience ranged between 2 and 14 years. Nine of them administered the intervention and worked at a practice with locations spread throughout the Netherlands. They were trained before the start of the study at four 3-hour meetings. During the first meeting, information was given about the study and measurements were actually practiced. The next three meetings were composed according to the characteristics of effective programs for professional development (Joyce & Showers, 2002). These characteristics are: (a) theory, (b) demonstration, (c) practice, (d) coaching, and (e) feedback. Theories about learning enhancing verbal feedback were presented in the second meeting, along with practicing on providing feedback when learning each other activities they were experts in (e.g., playing guitar). In the third and fourth meetings, pediatric physical therapists were video-coached in groups of 4/5 on the feedback they provided during the treatment sessions they had taped at their local practice. A trained coach (LV) supervised, demonstrated, and provided feedback. There was explicit attention for the transfer of theory into practice and the effect of the feedback on the children. The pediatric physical therapists also provided peer feedback.

Twenty-one pediatric physical therapists administered care-as-usual. These therapists received information about the study and practiced measurements. However, they were told that they were participating in an efficacy study that investigated the effect of care-as-usual on motor performance and physical activity in children with pDCD and were therefore blinded for treatment.

Five assessors were trained in administering the measurements before the start of the study. Measurements were also practiced during the study period to make sure the assessments were performed correctly. The assessors were blinded for treatment allocation.

Sample size calculation

We based our sample size calculation on the minimum detectable change (MDC) on the MABC-2 of 1.21, indicating that there is a reasonable level of confidence that the change is real when children with pDCD improve their motor performance by 1.21 points (Wuang, Su, & Su, 2012). With an 80% probability that the current study would detect a treatment effect at a two-sided .05 significant level, the required number of subjects was 19 for the intervention and 19 for the care-as-usual group (total of 38 children) (http://stat.ubc.ca/). The total sample size was set on 46 children because we anticipated 20% (n = 8) missing observations and dropouts.

Assessment

Children in the intervention and the care-as-usual group were assessed at baseline (T0), after 12 treatment sessions (trial end-point) (T1), and after 3 months of no intervention (follow-up) (T2). The intervening pediatric physical therapist performed the baseline assessment, while assessors performed the other two assessments. All assessments, except three, were performed in the practice of the pediatric physical therapist that administered the intervention. Trained assessors who were unaware of the current study assessed the typically developing children between January 2012 and June 2012. Assessments took approximately 1 hour (20 minutes to fill in questionnaires and 40 minutes to perform the MABC-2, to instruct the pedometer, and to hand out questionnaires for the parents).

Treatment procedure

Care-as-usual

Children with pDCD received 12 treatment sessions (each 30 minutes) once a week. Treatment goals were set for each child individually based on the clinical problem(s) and assessment of the child's motor performance. Next, treatment sessions focused on the intersection of the motor activity and the underlying motor skills problems resulting in a tailor made and reproducible intervention, in which deficient motor activities were being practiced. For example, children who experience difficulties in participating in ball activities (e.g., basketball) were first examined to investigate the underlying motor skills problems (e.g., timing, bouncing, throwing). During treatment sessions different kind of ball activities were practiced paying specific attention on improving timing, bouncing, and/or throwing. If these underlying motor skills problems are performed adequately they were linked back to, and practiced in, the motor activity (basketball). Further standardization of the intervention is undesirable, as it does not justify the reality of the pediatric therapist practice.

Intervention group

Children in the intervention group received the same intervention as children in the care-as-usual group, but the pediatric physical therapists specially focused on enhancing the pDCD children's perceived athletic competence by first setting specific treatment goals with the child in the first treatment session and second giving positive, specific, and progress feedback throughout every treatment session. During several sessions, using a visual analogue scale (VAS) for children, the child was asked how he perceived himself in performing the task and how motivated he was in getting better in this specific task. In doing so, the child became aware of his progress.

Measurements: Motor performance

Movement Assessment Battery for Children – Second Edition (MABC-2)

Motor performance was assessed using the MABC-2 (Henderson, Sugden, & Barnett, 2007). This test is divided into three different age bands (3–6, 7–10, and 11–16 years), each consisting of eight items to measure children's motor performance. The eight items are divided into three subsets: manual dexterity (three items), aiming and catching (two items), and balance (three items). Raw scores are converted into standard scores (1–19) and percentile scores (0–100) so results can be compared with peers of the same age. Scores above the 16th percentile are regarded as normal motor performance. Scores between the 6th and 16th percentile are considered "at risk" for motor difficulties and scores ≤ 6th percentile indicate significant motor difficulties. We used standard scores (1–19) for analyses. The MABC-2 has reasonable to good clinical utility in identifying children with motor performance differences (Brown & Lalor, 2009). Test-retest reliability (ICC = .97) and internal consistency (α = .90) for the total score are excellent (Wuang, Su, & Su, 2012).

Developmental Coordination Disorder Questionnaire 2007 (DCD-Q 2007)

Motor difficulties were assessed using the Dutch translation of the Developmental Coordination Disorder Questionnaire 2007 (DCD-Q 2007). The questionnaire consists of 15 items divided into three subsets: control during movement (six items), fine motor/handwriting (four items), and general coordination (five items). Every item is scored by one of the parents on a five-point scale (maximum score 75) with higher scores indicating fewer problems in participation by the child. Raw scores (15–75) were used for analyses. Based on the total score, children are categorized as: (a) indication or suspected DCD (≤ 15th percentile), or (b) probably no DCD (> 15th percentile). Internal consistency of the DCD-Q 2007 for children ≥ 8 year is high (α = .90), and sensitivity (81.6%) and specificity (84%) are acceptable (Schoemaker et al., 2006).

Measurements: Self-perceptions

The Self-Perception Profile for Children (SPPC)

The Dutch translation of the SPPC (Veerman, Straathof, Treffers, Van den Bergh, & Ten Brink, 1997) consists of 36 questions divided into six subscales. In this study we used the subscales *perceived athletic competence* and *global self-esteem*. Each question consists of two contradictory quotes. The child has to choose which quote describes him best. For example: 'some kids are really good at sports' or 'other kids are not so good at sports'. After choosing one of the quotes, the child has to indicate whether this was either 'a little bit true for me' or 'totally true for me'. The total score per subscale ranges between 6 and 24 points and was used for analyses. Higher scores indicate a more positive perception of athletic competence and global self-esteem. Scores are converted to percentile scores (0–100), whereby children scoring ≤ 15th percentile are considered as having low perceived athletic competence or global self-esteem and children scoring > 15th percentile are considered as having normal to high perceived athletic competence or global self-esteem. The scale was developed for children between 8 and 12 years. Internal consistency was high for perceived athletic competence (α = .81) and global self-esteem (α = .80), and test-retest reliability was also high for perceived athletic competence (ICC = .90) and global self-esteem (ICC = .86) (Muris, Meesters, & Fijen, 2003).

How Am I Doing questionnaire

Perceived motor competence and motor task values were assessed by asking children to complete the How Am I Doing questionnaire (Calame et al., 2009). This questionnaire consists of 13 items that can be divided into three subsets: fine motor activities (five items), ball activities (three items), and gross motor activities (five items). Every activity is scored on a 4-point-scale (maximum score 52) with higher scores indicating a more positive perception of motor competence or motor task values. The questionnaire was developed for children aged 6 to 12 years. Firstly, children were presented a photo of a specific motor activity (e.g., throwing, climbing, handwriting) and were asked how they perceived themselves in performing this specific motor activity, e.g., "how good do you perceive yourself at climbing". This resulted in the subscales perceived fine motor competence, perceived ball competence, and perceived gross motor competence. Secondly, for every item children were asked how important it was for them to be good at performing this specific motor activity, e.g., "how important is it for you to be good at climbing". This resulted in the subscales fine motor task values, ball task values, and gross motor task values. Internal consistency was acceptable for perceived motor competence ($\alpha = .66$) and motor task values ($\alpha = .76$). Likewise, test-retest was satisfactory for both perceived motor competence ($r = .76$) and motor task values ($r = .63$) (Volman et al., 2009).

Measurements: Physical activity

Yamax CW700 Digiwalker Pedometer

Total physical activity was assessed with the Yamax CW700 Digiwalker Pedometer. The Yamax CW700 registers every step ("count") for each vertical motion that surpasses a threshold force of 0.35 g. Children were asked to wear the Yamax CW700 for 7 consecutive days. We used the average steps per day for analyses. An earlier version of the Yamax CW700, the Yamax S200-Digiwalker Pedometer, has excellent interinstrument reliability (ICC .96–.99)(e.g., Barfield, Rowe, & Michael, 2004). The Yamax CW700 Digiwalker is a newer, more advanced version of the Yamax SW200 and is able to store day-to-day data for 7 days, unlike the Yamax SW200.

7-day activity diary

Leisure physical activity was assessed using a 7-day activity diary. Parents were asked to report their child's activities after school and on weekends daily for 7 consecutive days. The activity diary consists of 30 minutes time blocks between 15:00 and 19:00 on Monday, Tuesday, Thursday, and Friday, between 12:30 and 19:00 on Wednesday[2], and between 08.00 and 19.00 on Saturday and Sunday. Every time block was scored based on Bouchard's method (Bouchard et al., 1983) to assess the energy expenditure of the activity (scores between 1 and 9): higher scores indicated higher energy expenditure. Next, we categorized every time block as *physical activity* or *no physical activity*. Activities with a score of 6 (e.g., leisure activities outside) or higher were considered as *physical activity* and scores below 6 were considered as *no physical activity*. We then summed up the number of time blocks that were categorized as *physical activity*. We divided the number of time blocks that were categorized as *physical activity* by the number of time blocks that were filled in to calculate the percentage that children were physically active after school and on weekends, as done previously in Noordstar et al. (2016a). Proxy reports for physical activity appear to be adequate and suitable with parental proxy reports significantly correlating with heart rate monitoring (r = .71–.81 per day and r = .68 for a 3-day period) (Manios, Kafatos, & Markakis, 1998).

Statistical analysis

First, we used Mann-Whitney U tests to analyze differences between the intervention group and the care-as-usual group at baseline for motor performance, motor difficulties, perceived athletic competence, perceived motor competence, motor task values, and global self-esteem. We used T-tests to analyze differences between the intervention and the care-as-usual group at baseline for total physical activity and leisure physical activity, after we performed Kolmogorov-Smirnov tests to test for normality of the data ($p > .200$).

Second, we used mixed linear models to estimate the effects of the intervention on all outcome measures. Mixed linear models are more able to handle missing data and uneven spacing between time points than repeated measures analysis of variance. We investigated differences between baseline and trial end-point, between trial end-point and 3-month follow-up, and between baseline and 3-month follow-up. Group, time, and the interaction between group and time were included as fixed effects in the model; a random effect was estimated for the intercept. If significant, uncorrected post-hoc analyses (i.e., LSD) were used to investigate differences between groups at different time points and between time points. There were no missing values for motor performance, perceived motor competence, and motor task values. We used multiple imputations to estimate the (negligible) number of missing items (< 1%) for perceived athletic competence and global self-esteem. We removed the test result for a

2 Children in Dutch elementary schools are free on Wednesday afternoons.

specific time point for motor difficulties (T0: $n = 0$; T1: $n = 6$; T2: $n = 6$), leisure physical activity (T0: $n = 6$; T1: $n = 9$; T2: $n = 10$), and total physical activity (T0: $n = 1$; T1: $n = 4$; T2: $n = 7$) if *less* than 50% of the values were filled-in. We estimated the missing values using multiple imputations for motor difficulties and total physical activity if *more* than 50% of the items were filled in. With regard to leisure physical activity, multiple imputations were not necessary because we calculated a percentage of leisure physical activity using only the time blocks that were filled in. All available data were used, with analyses based on the principle of intention-to-treat.

Third, we performed Kruskal-Wallis tests to investigate differences in self-perceptions among the intervention group, the care-as-usual group, and the control group of typically developing children. We furthermore performed one-way ANOVAs to investigate differences in total physical activity and leisure physical activity among the intervention group, the care-as-usual group, and the group of typically developing children. This way we investigated if differences in self-perceptions and physical activity became smaller over time between children with pDCD and typically developing children. If significant, uncorrected post-hoc analyses were used to investigate differences between every pair of groups. All analyses were performed using SPSS 20.0. Statistical significance was set to $p < .05$.

Results

Participant characteristics

Eight pediatric physical therapists included children for the intervention group while seven therapists included children for the care-as-usual group. Years of experience was the same between the pediatric physical therapists who administered the intervention (range 2–12 years) and the pediatric physical therapists who administered the care-as-usual (5–14 years), U ($n = 15$) = 14.50, $p = .121$.

The intervention group consisted of 20 children (13 boys), mean age 8.15 (0.93) years. The care-as-usual group consisted of 11 children (8 boys), mean age 8.09 (1.14) years. Age at baseline, U ($n = 31$) = 102.50, $p = .761$, school type distribution, χ^2 (1, $n = 31$) = .132, $p = .717$, and gender distribution, χ^2 (1, $n = 31$) = .194, $p = .660$, were the same in both groups. The intervention and the care-as-usual group scored the same on all primary and secondary outcome measures at baseline with the exception of perceived gross motor performance. Children in the care-as-usual group perceived themselves higher for gross motor performance than children in the intervention group, U (n = 31) = 39.5, p = .003. Results on all primary and secondary outcome measures are reported in Table 4.1.

Motor performance

We found no effect of the intervention on motor performance. However, motor performance improved over time, $F(2, 58) = 6.07$, $p = .004$. Post-hoc analyses revealed that children in both the intervention and care-as-usual group improved their motor performance after 12 treatment sessions ($p = .005$). This improvement was maintained at the 3-month follow-up ($p = .003$). On examination of the individual MABC-2 components we found no effect of the intervention for any of the individual MABC-2 components. We found that aiming and catching, $F(2, 58) = 3.76$, $p = .029$, and balance, $F(2, 58) = 6.03$, $p = .004$, improved over time in both the intervention and care-as-usual group, but manual dexterity, $F(2, 58) = .56$, $p = .572$, did not. Aiming and catching ($p = .053$) improved almost significantly, and balance improved significantly ($p = .034$), after 12 treatment sessions. This improvement in aiming and catching ($p = .011$) and balance ($p < .001$) was maintained at the 3-month follow-up.

We found no effect of the intervention on motor difficulties as reported on the DCD-Q. However, motor difficulties decreased over time, $F(2, 49.2) = 10.52$, $p < .001$. Post-hoc analyses revealed that parents rated their children in both the intervention and care-as-usual group as experiencing fewer motor difficulties after 12 treatment sessions ($p < .001$). This improvement was maintained at the 3-month follow-up ($p < .001$) (Table 4.2).

Self-perceptions

We found no effect of the intervention on perceived athletic competence and global self-esteem. However, perceived athletic competence, $F(2, 58) = 9.00$, $p < .001$, and global self-esteem, $F(2, 58) = 3.51$, $p = .036$, increased over time in children in both the intervention and care-as-usual group. Perceived athletic competence ($p < .001$) and global self-esteem ($p = .044$) increased after 12 treatment sessions. This increase in perceived athletic competence ($p = .002$) and global self-esteem ($p = .016$) was maintained at the 3-month follow-up.

With regard to perceived motor competence and motor task values, we found no effect of the intervention on perceived fine motor competence and perceived ball competence. However, we found that perceived gross motor competence, $F(1, 29) = 4.29$, $p = .047$, was higher in children in the care-as-usual group. Perceived fine motor competence, $F(2, 58) = 4.76$, $p = .012$, and perceived ball competence, $F(2, 58) = 4.99$, $p = .010$, increased significantly over

Table 4.1 Means and standard deviations of primary and secondary outcomes at each time-point

	Baseline				After 12-treatment sessions				3-month follow-up			
	n	Intervention *M* (*SD*)	*n*	Care as usual *M* (SD)	*n*	Intervention *M* (*SD*)	*n*	Care as usual *M* (*SD*)	*n*	Intervention *M* (*SD*)	*n*	Care as usual *M* (*SD*)
Motor performance (1–19)												
Manual dexterity	20	4.4 (3.1)	11	5.4 (3.4)	20	5.1 (2.6)	11	5.8 (4.3)	20	5.1 (3.0)	11	5.8 (3.1)
Aiming and catching	20	4.6 (2.2)	11	5.7 (2.8)	20	6.3 (3.2)	11	6.2 (3.7)	20	6.3 (2.8)	11	6.9 (2.6)
Balance	20	5.1 (2.7)	11	5.5 (4.3)	20	5.9 (3.2)	11	6.7 (3.2)	20	6.6 (2.8)	11	7.2 (3.4)
Total score	20	3.1 (1.5)	11	3.8 (2.4)	20	4.2 (2.3)	11	5.6 (4.1)	20	4.5 (2.4)	11	5.5 (3.0)
MD (15–75)	20	41.5 (9.2)	11	41.3 (8.5)	17	50.3 (13.1)	8	48.1 (9.4)	17	53.4 (11.9)	8	47.5 (4.3)
PAC (6–24)	20	14.8 (4.3)	11	17.1 (4.0)	20	17.9 (3.6)	11	19.7 (4.1)	20	17.5 (4.2)	11	19.2 (3.3)
GSE (6–24)	20	19.1 (2.8)	11	19.8 (3.7)	20	20.3 (3.6)	11	21.5 (2.3)	20	21.1 (2.5)	11	21.3 (2.6)
PMC												
PFMC (5–20)	20	13.1 (2.3)	11	13.0 (3.7)	20	14.7 (2.3)	11	13.1 (3.4)	20	14.8 (2.6)	11	14.4 (2.2)
PBC (3–12)	20	8.0 (2.0)	11	8.8 (1.8)	20	9.7 (1.8)	11	9.4 (1.5)	20	9.4 (1.3)	11	9.5 (1.5)
PGMC (5–20)	20	16.3 (2.5)[a]	11	18.7 (1.6)[a]	20	17.0 (2.0)	11	17.7 (2.2)	20	17.5 (2.0)	11	17.7 (2.0)
MTV												
FMTV (5–20)	20	15.4 (2.9)	11	15.3 (3.5)	20	16.0 (2.0)	11	15.0 (3.8)	20	16.4 (2.9)	11	15.4 (4.3)
BTV (3–12)	20	9.0 (1.9)	11	8.4 (2.0)	20	9.1 (2.3)	11	8.7 (2.4)	20	8.7 (2.3)	11	9.4 (2.1)
GMTV (5–20)	20	15.9 (2.2)	11	17.2 (3.3)	20	16.1 (2.1)	11	16.1 (2.3)	20	15.8 (2.5)	11	15.9 (3.2)
PA (steps / day)	20	9607 (2280)	10	8340 (2233)	18	10161 (2686)	9	8968 (2551)	15	9870 (2735)	9	8770 (2390)
LPA (percentage)	17	.22 (.12)	8	.13 (.07)	13	.22 (.12)	9	.24 (.15)	12	.28 (.16)	9	.20 (.10)

Note. MD = motor difficulties (DCDQ); PMC = perceived motor competence; MTV = motor task values; PFMC = perceived fine motor competence; PBC = perceived ball competence; PGMC = perceived gross motor competence; FMTV = fine motor task values; BTV = ball task values; GMTV = gross motor task values; PAC = perceived athletic competence; GSE = global self-esteem; PA = total physical activity; LPA = leisure physical activity; [a] = significantly different at baseline ($p < .05$).

4

Table 4.2 Estimated fixed and random effects for primary and secondary outcomes between baseline, trial endpoint, and follow-up

	Fixed effects									Random effects	
	Intervention			Time[1]			Intervention x Time[2]			Intercept	
	Est. (*SE*)	*F*	*p*	Est. (*SE*) T0-T2 Est. (*SE*) T1-T2	*F*	*p*	Est. (*SE*) T0 x Int. Est. (*SE*) T1 x Int.	*F*	*p*	Est. (*SE*)	*p*
MABC-2											
MDex	-0.77 (1.19)	0.730	.400	-0.45 (.99) 0.00 (.99)	0.564	.572	-0.20 (1.23) 0.05 (1.23)	0.022	.978	4.70 (1.74)	.007
A&C	-0.61 (1.08)	0.379	.543	-1.18 (.88) -0.73 (.88)	3.763	.029[b]	-0.52 (1.09) 0.73 (1.09)	0.656	.523	4.04 (1.46)	.006
B	-0.58 (1.19)	0.346	.561	-1.73 (.77) -0.45 (.77)	6.027	.004[a, b]	0.18 (0.95) -0.30 (0.95)	0.125	.883	6.84 (2.09)	.001
Total	-1.00 (0.96)	1.728	.199	-1.64 (.77) 0.09 (.77)	6.071	.004[a, b]	0.29 (.96) -0.39 (.96)	0.252	.778	3.35 (1.18)	.005
MD	6.52 (4.25)	0.840	.367	-5.44 (3.45) 1.07 (3.76)	10.516	< .001[a, b]	-6.31 (4.20) -4.21 (4.54)	1.134	.330	54.77 (20.12)	.006
PAC	-1.73 (1.49)	2.514	.124	-2.04 (1.15) 0.55 (1.15)	8.995	< .001[a, b]	-0.60 (1.43) -0.10 (1.43)	0.103	.902	8.48 (2.90)	.003
GSW	-0.22 (1.12)	0.840	.367	-1.44 (1.11) 0.18 (1.11)	3.510	.036[a, b]	-0.54 (1.38) -0.93 (1.38)	0.229	.796	2.05 (1.21)	.089
PMC											
PFMC	0.39 (1.01)	0.657	.424	-1.36 (0.79) -1.27 (0.79)	4.757	.012[b]	-0.29 (0.98) 1.17 (0.98)	1.249	.294	3.89 (1.33)	.004
PBC	-0.20 (0.64)	0.244	.625	-0.73 (0.61) -0.18 (0.61)	4.992	.010[a, b]	-0.57 (0.76) 0.48 (0.76)	0.957	.390	0.79 (0.41)	.053
PGMC	-0.23 (0.79)	4.288	.047	1.00 (0.78) 0.00 (0.78)	0.162	.851	-2.25 (0.97) -0.55 (0.97)	2.945	.061	1.12 (0.62)	.070

Table 4.2 continues on next page.

Table 4.2 ***Continued***

	Fixed effects									Random effects	
	Intervention			Time[1]			Intervention x Time[2]			Intercept	
	Est. (*SE*)	*F*	*p*	Est. (*SE*) T0-T2 Est. (*SE*) T1-T2	*F*	*p*	Est. (*SE*) T0 x Int. Est. (*SE*) T1 x Int.	*F*	*p*	Est. (*SE*)	*p*
MTV											
FMTV	0.99 (1.17)	0.482	.493	-0.09 (0.91) -0.36 (0.91)	0.489	.616	-0.91 (1.13) -0.36 (1.13)	0.413	.663	5.12 (1.76)	.004
BTV	-0.71 (0.82)	0.024	.877	-1.00 (0.73) -0.64 (0.73)	0.273	.762	1.35 (0.91) 1.09 (0.91)	1.249	.295	1.84 (0.76)	.015
GMTV	-0.16 (0.96)	0.452	.507	1.27 (0.89) 0.18 (0.89)	0.839	.438	-1.12 (1.11) 0.17 (1.11)	0.799	.455	2.12 (0.98)	.030
PA	1206 (1027)	2.631	.116	-338 (892) 193 (923)	0.535	.589	60 (1117) 8 (1148)	0.002	.998	2421178 (1019127)	.018
LPA	0.07 (0.55)	1.530	.228	-0.07 (0.06) 0.04 (0.05)	1.991	.149	0.02 (0.07) -0.11 (0.07)	1.743	.187	0.00 (0.00)	.241

Note. [a] = significant difference between baseline and trial endpoint; [b] = significant difference between baseline and follow-up; [c] = significant difference between trial endpoint and follow-up; MDex = manual dexterity; A&C = aiming and catching; B = balance; Total = total score; MD = motor difficulties; PAC = perceived athletic competence; GSE = global self-esteem; PMC = perceived motor competence; PFMC = perceived fine motor competence; PBC = perceived ball competence; PGMC = perceived gross motor competence; MTV = motor task values; FMTV = fine motor task values; BTV = ball task values; GMTV = gross motor task values; PA = physical activity; LPA = leisure physical activity; Est. = estimate; SE = standard error; Int. = intervention.
Time[1] = the upper estimate is difference between follow-up and baseline, and the lower estimate is difference between follow-up and trial end-point.
Intervention x Time[2] = upper estimate is interaction between group and time at baseline, and the lower estimate is interaction between time and trial end-point, with follow-up as reference value.

time in children in both the intervention and care-as-usual group, while perceived gross motor competence did not, $F(2, 58) = 0.162$, $p = .851$. Perceived fine motor competence increased between baseline and the 3-month follow-up ($p = .003$), while perceived ball competence increased after 12 treatment sessions ($p = .007$). This increase in perceived ball competence was maintained at the 3-month follow-up ($p = .010$). There was no effect of the intervention on perceived fine motor competence, perceived ball competence, and perceived gross motor competence. Furthermore, we found no effect of the intervention for any of the motor task values. Furthermore, motor task values did not change during the study period (Table 4.2).

Physical activity

We found no effect of the intervention on leisure physical activity and total physical activity. Furthermore, leisure physical activity and total physical activity did not change during the study period (Table 4.2).

Intra-group variability

Random intercepts of almost all primary and secondary outcome measures were significant, indicating large intra-group variability at baseline (Table 4.2). We investigated individual changes by examining the number of children that increased or decreased ≥ 1 MDD on the MABC-2. In doing so, the group data became more transparent. Overall, most children in the intervention ($n = 12$; 60%) and the care-as-usual group ($n = 5$; 46%) increased their motor performance after 12 treatment sessions. This improvement was maintained at the 3-month follow-up. However, differences *within* the intervention and the care-as-usual group, and *between* the subsets of the MABC-2, were considerable (Table 4.3).

We also examined the change in perceived athletic competence on an individual level where we categorized children as having low (≤ 15th percentile) or normal (> 15th percentile) levels of perceived athletic competence. We found that the vast majority of children in the intervention (82%) and the care-as-usual group (100%) with low levels of perceived athletic competence at baseline had normal levels of perceived athletic competence after 12 treatment sessions. This number decreased at 3-month follow-up, but more than half of the children in the intervention (64%) and care-as-usual group (67%) still had normal levels of perceived athletic competence (Table 4.4).

Table 4.3 Change on the MABC-2 in children who scored ≤ 16th percentile at baseline

	After 12-treatment sessions			At follow-up		
	Decreased (≥ 1 MDD) *n* (%)	Remained stable *n* (%)	Increased (≥ 1 MDD) *n* (%)	Decreased (≥ 1 MDD) *n* (%)	Remained stable *n* (%)	Increased (≥ 1 MDD) *n* (%)
Intervention group						
Manual dexterity (*n* = 16)	2 (12)	3 (19)	11 (69)	4 (25)	4 (25)	8 (50)
Aiming and catching (*n* = 18)	3 (17)	6 (33)	9 (50)	2 (11)	5 (28)	11 (61)
Balance (*n* = 16)	4 (25)	2 (12)	10 (63)	3 (19)	1 (6)	12 (75)
Total score (*n* = 20)	5 (25)	3 (15)	12 (60)	5 (25)	2 (10)	13 (65)
Care as usual group						
Manual dexterity (*n* = 10)	4 (40)	1 (10)	5 (50)	4 (40)	0 (0)	6 (60)
Aiming and catching (*n* = 8)	2 (25)	4 (50)	2 (25)	1 (12)	3 (38)	4 (50)
Balance (*n* = 9)	1 (11)	0 (0)	8 (89)	0 (0)	1 (11)	8 (89)
Total score (*n* = 11)	2 (18)	4 (36)	5 (46)	1 (9)	3 (27)	7 (64)

Note. MDD = minimal detectable difference.

Table 4.4 Children who changed categories for perceived athletic competence

	PAC After 12-treatment sessions		PAC At follow-up	
Baseline	≤ 15th percentile *n* (%)	> 15th percentile *n* (%)	≤ 15th percentile *n* (%)	> 15th percentile *n* (%)
Intervention group (*n* = 20)				
< 15th percentile (*n* = 11)	2 (18)	9 (82)	4 (36)	7 (64)
> 15th percentile (*n* = 9)	1 (11)	8 (89)	0 (0)	9 (100)
Care as usual group (*n* = 11)				
< 15th percentile (*n* = 3)	0 (0)	3 (100)	1 (33)	2 (67)
> 15th percentile (*n* = 8)	1 (13)	7 (87)	0 (0)	8 (100)

Note. MDD = minimal detectable difference.

Benchmark between children with pDCD and typically developing children

Self-perceptions

We pooled the results of the intervention group and the care-as-usual group to increase power because there were no differences in treatment effects between the two groups[3] (n = 31). Children with pDCD had lower levels of perceived athletic competence, U (n = 174) = 999.50, $p < .001$, global self-esteem, U (n = 174) = 1398.50, $p < .001$, and perceived fine motor competence, U (n = 174) = 1081.00, $p < .001$, than typically developing children (n = 143) at baseline, while perceived ball competence and perceived gross motor competence were the same (Supplementary Table S4.1).

Differences for perceived athletic competence and global self-esteem were no longer significant after 12 treatment sessions, but differences for perceived fine motor competence still were, U (n = 174) = 1609.00, p = .016. At the 3-month follow-up, differences for global self-esteem and perceived fine motor competence were not significant, but differences for perceived athletic competence were, U (n = 174) = 1719, p = .049.

Fine motor task values, ball task values, and gross motor task values were the same in children with pDCD and typically developing children at baseline, after 12 treatment sessions, and at the 3-month follow-up.

3 Differences in psychological variables between the intervention group, the care-as-usual group, and typically developing children are reported in the Supplementary Table S4.2.

Physical activity

Again, we pooled the results of the intervention group and the care-as-usual group to increase power. We compared these results with total physical activity (*n* = 94) and leisure physical activity (*n* = 54) in typically developing children. Children with pDCD participated less in total physical activity and leisure physical activity than typically developing children at baseline, after 12 treatment sessions, and at the 3-month follow-up (Supplementary Table S4.1).

Discussion

We investigated the effect of an integrated behavioral and motor intervention (intervention) in children with pDCD, between 7 and 10 years of age, compared with a motor intervention only (care-as-usual).

Motor performance

After 12 treatment sessions, motor performance and motor difficulties were the same in both groups. We hypothesized that motor performance would improve more in the intervention group, due to the specific (positive) progress feedback given such as previously been shown to enhance learning in children and adolescents (see for review Hattie & Timperly, 2007; Shute, 2008). We based our hypothesis on a number of studies that found that specific progress feedback positively influences learning *cognitive* skills. However, no study had investigated whether specific progress feedback influenced learning *motor* skills. We argue that other determinants, like creating a playful, one-on-one situation where specific attention is paid to the child's current motor performance are stronger determinants for learning *motor* skills than specific positive progress feedback, which would explain the equal improvement in motor performance in both groups. The improvement in motor performance is in line with a number of studies that have investigated care-as-usual interventions in children with pDCD (see for review Smits-Engelsman et al., 2013). We argue that manual dexterity did not improve because it was not the primary focus of the intervention.

Self-perceptions

Levels of perceived athletic competence and global self-esteem were the same in the intervention and the care-as-usual group after 12 treatment sessions. This result could be explained by the fact that the pediatric physical therapists in the care-as-usual group also enhanced, possibly unknowingly, children's perceived athletic competence during the treatment sessions. Also, although teachers seldom provided the types of feedback interventions identified as effective for motor learning, a number of teachers provide specific positive feedback to their students *without* being specifically trained to do so (Voerman, Meijer, Korthagen, & Simons, 2012).

Global self-esteem is influenced by a number of domain specific self-perceptions (e.g., perceived scholastic competence), which are, in turn, influenced by specific activities (e.g., Schmidt, Blum, Valkanover, & Conzelmann, 2015). We argue that children in the intervention and the care-as-usual group improved in a number of specific activities during our study period, and, in turn, also in their self-perceptions. We speculate that this improvement in specific activities and self-perceptions was the same in the intervention and the care-as-usual group, resulting in an equal increase in global self-esteem.

Perceived athletic competence and global self-esteem were the same at the 3-month follow-up because children in both groups also improved equally after 12 treatment sessions.

With regard to the self-perceptions that were measured with the How Am I Doing questionnaire, we argue that perceived fine motor competence was the same in the intervention and the care-as-usual group after 12 treatment sessions because (perceived) fine motor competence was not the focus of our intervention. We found high levels of perceived gross motor competence in the care-as-usual group at baseline. They were also significantly higher than the levels of perceived gross motor competence in the intervention group at baseline. Because of a ceiling effect for perceived gross motor competence in the care-as-usual group, significant differences in improvement between the intervention and care-as-usual group was difficult to achieve after 12 treatment sessions.

Fine motor task values, ball task values, and gross motor task values remained the same over time in both groups. Children were asked to rate how important it was for them to be good at specific activities that are essential for daily life (e.g., swimming, handwriting, tying shoelaces). We argue that children are aware that these activities are important in daily life, whether or not they are able to perform them, resulting in fairly stable motor task values in both groups throughout our study period (Noordstar et al., 2016b).

Physical activity

Total physical activity and leisure physical activity were the same in the intervention and the care-as-usual group after 12 treatment sessions and the 3-month follow-up and remained stable over time in both groups. Although the model by Stodden et al. (2008)

implies reciprocal *direct* associations between motor performance and physical activity and *indirect* associations between motor performance and physical activity through perceived motor competence, the strength of these associations are only small to moderate in typically developing children (e.g., Davison, Downs, & Birch, 2006). Moreover, we think that the improvement in motor performance and perceived competence in children with pDCD was too small to substantially influence their participation in total physical activity and leisure physical activity in the intervention group.

We performed a second analysis, based on the activity diaries filled in by parents, where we investigated if the intervention group participated less in sedentary behavior than the care-as-usual group after 12 treatment sessions and at the 3-month follow-up. We found no differences between the intervention group and the care-as-usual group, but there was a significant decrease in sedentary behavior over time for all children (p = .049).

Intra-group variability

We found large intra-group variability in the improvement in motor performance. This result is in accordance with others (e.g., Ferguson, Jelsma, Jelsma, & Smits-Engelsman, 2013). Children with pDCD are a heterogeneous group (e.g., Vaivre-Douret et al., 2011), so variability in improvement after a motor intervention can be expected. However, future research should take this intra-group variability into account. We argue that investigating determinants of the children with pDCD who improved, remained stable, or decreased would provide vital information for developing motor intervention programs for children with pDCD.

Also, we found large intra-group variability in perceived athletic competence at baseline, which is in accordance with others (e.g., Noordstar et al., 2014). Noordstar et al. (2014) speculated that in their study children with DCD already received pediatric physical therapy, which increased their perceived athletic competence. However, in our study children were assessed before they received pediatric physical therapy. Apparently, although self-perceptions are argued to be realistic from the age of 7 (Harter, 2006), there is still a large number of children with pDCD between 7 and 10 years of age who's self-perceptions are more positive than their actual motor performance.

Differences benchmarked with typically developing children

Self-perceptions

As hypothesized, children with pDCD had lower levels of perceived athletic competence, global self-esteem, and perceived fine motor competence than typically developing children at baseline. This result is in accordance with several other studies (e.g., Poulsen, Ziviani, & Cuskelly, 2008). However, children with pDCD perceived themselves the same in perceived ball competence, perceived gross motor competence, and motor task values at baseline. We have no clear explanation for this result but, with regard to perceived gross motor competence, we speculate that the questions that were used to evaluate perceived gross motor competence made it difficult to make a qualified judgment. Moreover, children are able to perform the activity or not. This clear distinction resulted in a high and stable perceived gross motor competence because children were between 7 and 10 years of age and, therefore, able to perform most activities (e.g., climbing, running). With regard to motor task values, we feel, as mentioned before, that children are aware that the activities that they were asked to evaluate are important in daily life, equally so for children with pDCD and typically developing children, resulting in an equal level of motor task values.

As children improved their self-perceptions after 12 treatment sessions, differences between children with pDCD and typically developing children became smaller and were no longer significant. Perceived fine motor competence was the only exception, but as mentioned before, (perceived) fine motor competence was not the (primary) focus of the treatment sessions. Differences remained non-significant at the 3-month follow-up, except for perceived athletic competence, where children with pDCD had lower levels for perceived athletic competence than typically developing children. Children with pDCD received no positive feedback from their pediatric physical therapist during the 3-month follow-up period, possibly resulting in a decline in perceived athletic competence.

Physical activity

As hypothesized, children with pDCD participated less in physical activity than typically developing children at baseline. This result is in line with other studies that have investigated differences in physical activity between children with pDCD and typically developing children (e.g., Cairney et al., 2010; Noordstar et al., 2014). However, children with pDCD participated still less in physical activity after 12 treatment sessions and at the 3-month follow-up. As argued before, the improvement in motor performance and perceived athletic competence was of insufficient magnitude to improve participation in physical activity in children with pDCD.

Weaknesses and strengths of the study

Several limitations of this study have to be recognized. Firstly, we included children based on their motor performance and physical activity scores, but not on their perceived athletic competence scores. We assumed, based on an extensive number of studies, perceived athletic competence in children with pDCD to be low. However, in retrospect, we should have taken low perceived athletic competence as an inclusion criterion, as a number of children ($n = 17$) had normal levels of perceived athletic competence at baseline. Had we done so, the effect of the intervention might have been larger because the intervention focused on improving perceived athletic competence in addition to motor performance. Secondly, the number of children in the care-as-usual group was smaller than we had determined in our sample-size calculation, making it harder to find significant differences between the intervention and the care-as-usual group. However, we speculate that a larger number of children in the care-as-usual group would not have significantly influenced the results because scores on the outcome measures were fairly similar in both groups. Thirdly, a large number of physical activity data was missing at the 3-month follow-up, making our results possibly less valid. However, missing data was taken into account because we used mixed linear models to investigate the effect of the intervention group and the care-as-usual group. Fourth, we did not take parental influences into account, while, for example, parents' encouragements and support can increase children's physical activity (e.g., Xu, Wen, & Rissel, 2015). Finally, we did not investigate whether children experienced comorbidities like attention deficit disorders, learning problems, and behavioral problems that frequently co-occur with pDCD (e.g., Kaiser, Schoemaker, Albaret, & Geuze, 2015). These comorbidities possibly affected the responsiveness to the intervention.

In terms of strengths of our study, this is the first to investigate the effect of an integrated behavioral and motor intervention in children with pDCD on motor performance, self-perceptions, and physical activity. We also investigated if any improvement was maintained after 3 months of no intervention and benchmarked our results to a group of typically developing children.

Conclusion

We found no significant advantages of an integrated behavioral and motor intervention compared with care-as-usual on motor performance, self-perceptions, and physical activity in children with pDCD. Because this study was underpowered, the conclusions need to be interpreted with caution. Children in the intervention and the care-as-usual group equally improved their motor performance and self-perceptions after 12 treatment sessions. This improvement was maintained at the 3-month follow-up, while physical activity remained unchanged.

Unfortunately, no specific content of the care-as-usual intervention was collected, but we speculate that the pediatric physical therapists that administered the care-as-usual may have unknowingly also enhanced the children's self-perceptions during treatment sessions. Based on the model by Stodden et al. (2008), we hypothesized that an increase in motor performance and self-perceptions would result in an increase in physical activity in children with pDCD. We assume that other determinants may play a role, in addition to self-perceptions, for pDCD children's participation in physical activity. More specifically, Stodden et al. (2008) argued that, besides perceived competence, physical fitness also mediates the association between motor performance and physical activity, while others (Deci & Ryan, 2002) have argued that autonomy and relatedness are important determinants for participation in physical activity. However, to date, studies investigating motivational principles to enhance physical activity are lacking for children with pDCD.

It is worth mentioning that we found large intra-group variability on the improvement in motor performance and self-perceptions in children with pDCD. Future research should focus on investigating motivational determinants of physical activity in children with pDCD in order to develop intervention programs to promote physical activity in children with pDCD, where the large intra-group variability should be taken into account.

Acknowledgements

We wish to acknowledge Marielle Dekker and Helene Steijn for training the pediatric physical therapists who participated in the intervention group. We also thank Taylor Krohn for her work in editing this manuscript and dr. Renske Schappin for her help with the statistical analyses. Finally, we thank "Vormingsfonds Oefentherapie Cesar" for funding the expenses incurred during this study.

What this paper adds

This is the first study that has investigated the effect of an integrated behavioral and motor intervention (intervention group) on motor performance, self-perceptions, and physical activity compared with a motor intervention (care-as-usual group) in children with pDCD. We made the behavioral component explicit by providing positive, specific, and progress feedback to enhance children's self-perceptions. Also, this is one of the first studies that has investigated the effect after both 12 treatment sessions (trial end-point) and after 3 months of no intervention (3-month follow-up). We found no differences between the intervention and the care-as-usual group, but children improved their motor performance and increased (most) of their self-perceptions after 12 treatment sessions, while physical activity remained the same. The improvement was still present at the 3-month follow-up. We also benchmarked our results about self-perceptions and physical activity to a group of typically developing children. Self-perceptions in children with pDCD had improved to the level of typically developing children after 12 treatment sessions, but their physical activity levels remained significantly lower. This result was the same at the 3-month follow-up, except for perceived athletic competence, which was lower in children with pDCD at the 3-month follow-up. In accordance with previous intervention studies that have investigated children with pDCD, we found large intra-group variability in the change in motor performance and self-perceptions in children with pDCD. We argue that we need to better understand why some children with pDCD improve and others do not after a motor intervention.

References

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). Washington, DC: American Psychiatric Association.

Barfield, J. P., Rowe, D. A., & Michael, T. J. (2004). Interinstrument consistency of the Yamax Digiwalker Pedometer in elementary school-aged children. *Measurement in Physical Education and Exercise Science, 8*, 109-116. doi: 10.1207/s15327841mpee0802_5

Blank, R., Smits-Engelsman, B., Polatajko, H., & Wilson, P. (2012). European Academy for Childhood Disability (EACD): Recommendations on the definition, diagnosis and intervention of developmental coordination disorder (long version). *Developmental Medicine & Child Neurology, 54*, 54-93. doi: 10.111/j.1469-8749.2011.04171.x

Bouchard, C., Tremblay, A., Leblanc, C., Lortie, G., Savard, R., & Theriault, G. (1983). A method to assess energy expenditure in children and adults. *The American Journal of Clinical Nutrition, 37*, 461-467.

Brown, T., & Lalor, A. (2009). The movement assessment battery for children - second edition (MABC-2): A review and critique. *Physical & Occupational Therapy in Pediatrics, 29*, 86-103. doi: 10.1080/01942630802574908

Cairney, J., Hay, J. A., Faught, B. E., Wade, T. J., Corna, L., & Flouris, A. (2005). Developmental coordination disorder, generalized self-efficacy toward physical activity, and participation in organized and free play activities. *The Journal of Pediatrics, 147*, 515-520. doi: 10.1016/j/jpeds.2005.05.013

Cairney, J., Hay, J. A., Veldhuizen, S., Missiuna, C., & Faught, B. E. (2010). Developmental coordination disorder, sex, and activity deficit over time: A longitudinal analysis of participation trajectories in children with and without coordination difficulties. *Developmental Medicine & Child Neurology, 52*, e67-72. doi: 10.1111/j.1469-8749.2009.03520.x

Calame, E., Reinders, H., Smits-Engelsman, B. C. M., Schoemaker, M. M., Volman, M. J. M., & De Kloet, A. (2009). *Hoe ik vind dat ik het doe vragenlijst: Vragenlijst motorische competentiebeleving (How am I doing questionnaire: A questionnaire to investigate perceived motor competence)*. Unpublished manuscript.

Chiviacowsky, S., & Wulf, G. (2007). Feedback after good trials enhances learning. *Research Quarterly for Exercise and Sport, 78*, 40-47. doi: 10.1080/02701367.2007.10599402

Davison, K. K., Downs, D. S., & Birch, L. L. (2006). Pathways linking perceived athletic competence and parental support at age 9 years to girls' physical activity at age 11 years. *Research Quarterly for Exercise and Sport, 77*, 23-31. doi: 10.1080/02701367.2006.10599328

Deci, E. L., & Ryan, R. M. (2002). *The handbook of self-determination research*. New York: University of Rochester Press.

Duijnhouwer, H. (2010). *Feedback effects on students' writing motivation, process and performance.* (Doctoral dissertation), Utrecht University, the Netherlands.

Eccles, J. S., Adler, T. F., Futterman, R., Goff, S. B., Kaczala, C. M., Meece, J. L., & Midgley, C. (1983). Expectancies, values, and academic behaviors. In J. T. Spence (Ed.), *Achievement and achievement motivation* (pp. 77-146). San Fransico, CA: W.H. Freeman.

Ferguson, G. D., Jelsma, D., Jelsma, J., & Smits-Engelsman, B. C. M. (2013). The efficacy of two task-oriented interventions for children with developmental coordination disorder: Neuromotor task training and Nintendo Wii Fit training. *Research in Developmental Coordination Disorder, 34*, 2449-2461 doi: 10.1016/j.ridd.2013.05.007

Harter, S. (1981). A model of mastery motivation in children: Individual differences and developmental change. In A. Collins (Ed.), *Minnesota Symposium on Child Psychology* (pp. 215-255). Hillsdale, NJ: Lawrence Erlbaum Associates.

Harter, S. (1982). The perceived competence scale for children. *Child Development, 53*, 87-97.

Harter, S. (2006). The self. In N. Eisenberg, W. Damon, & R. M. Lerner (Eds.), *Handbook of Child Psychology, 6th Edition, Volume 3: Social, Emotional, and Personality Development* (pp. 505-570). Hoboken, NJ: John Wiley & Sons.

Hattie, J. (2012). *Visible learning for teachers. Maximizing impact on learning.* New York: Routledge.

Hattie, J., & Timperly, H. (2007). The power of feedback. *Review of Educational Research, 77*, 81-112. doi: 10.3102/003465430298487

Henderson, S. E., Sugden, D. A., & Barnett, A. (2007). *Movement Assessment Battery for Children, 2nd Edition*. London: Psychological Corporation.

Imms, C., Adair, B., Keen, D., Ullenhag, A., Rosenbaum, P., & Granlund, M. (2015). 'Participation': A systematic review of language, definitions, and constructs used in intervention research with children with disabilities. *Developmental Disabilities & Child Neurology, 58*, 29-38. doi: 10.1111/dmcn.12932

Jelsma, D., Ferguson, G. D., Smits-Engelsman, B. C., & Geuze, R. H. (2015). Short-term motor learning of dynamic balance control in children with probable developmental coordination disorder. *Research in Developmental Disabilities, 38*, 213-222. doi: 10.1016/j.ridd.2014.12.027

Joyce, B., & Showers, B. (2002). *Student achievement through staff development*: New York: Longman.

Kaiser, M. L., Schoemaker, M. M., Albaret, J.M., & Geuze, R. H. (2015). What is the evidence of impaired motor skills and motor control among children with attention deficit hyperactivity disorder (ADHD)? Systematic review of the literature. *Research in Developmental Disabilities, 36*, 338-357. doi: 10.1016/j.ridd.2014.09.023

Kluger, A. N., & DeNisi, A. (1996). The effects of feedback interventions on performance: A historical review, a meta-analysis, and a preliminary feedback intervention theory. *Psychological Review, 119*, 254-284. doi: 10.1037/0033-2909.119.2.254

Losada, M., & Heaphy, E. (2004). The role of positivity and connectivity in the performance of business teams: A nonlinear dynamics model. *American Behavioral Scientist, 47*, 740-765. doi: 10.1177/0002764203260208

Manios, Y., Kafatos, A., & Markakis, G. (1998). Physical activity of 6-year-old children: Validation of two proxy reports. *Pediatric Exercise Science, 10*, 176-188.

Miller, L. T., Polatajko, H. J. Missiuna, C., Mandich, A. D., & Macnab, J. J. (2001). A pilot trial of a cognitive treatment for children with developmental coordination disorder. *Human Movement Science, 20*, 183-210. doi: 10.1016/s0167-9457(01)00034-3

Muris, P., Meesters, C., & Fijen, P. (2003). The self-perception profile for children: Further evidence for its factor structure, reliability, and validity. *Personality and Individual Differences, 35*, 1791-1802. doi: 10.1016/s0191-8869(03)00004-7

Noordstar, J. J., Van der Net, J., Jak, S., Helders, P. J. M., & Jongmans, M. J. (2016a). Global self-esteem, perceived athletic competence, and physical activity in children: A longitudinal cohort study. *Psychology of Sport and Exercise, 22*, 83-90. doi: 10.1016/j.psychsport.2015.06.009

Noordstar J. J., Van der Net, J., Jak, S., Helders, P. J. M., & Jongmans, M. J. (2016b). The change in perceived motor competence and motor task values during elementary school: A longitudinal cohort study. *British Journal of Developmental Psychology*, *34*, 427-446. doi: 10.1111/bjdp.12142

Noordstar, J. J., Stuive, I., Herweijer, H., Holty, L., Oudenampsen, C., Schoemaker, M. M., & Reinders-Messelink, H. A. (2014). Perceived athletic competence and physical activity in children with developmental coordination disorder who are clinically referred, and control children. *Research in Developmental Disabilities, 35*, 3591-3597. doi: 10.1016/j.ridd.2014.09.005

Piek, J. P., Baynam, G. B., & Barrett, N. C. (2006). The relationship between fine and gross motor ability, self-perceptions and self-worth in children and adolescents. *Human Movement Science, 25*, 65-75. doi: 10.1016/j.humov.2005.10.011

Poulsen, A. A., Ziviani, J. M., & Cuskelly, M. (2008). Leisure time physical activity energy expenditure in boys with developmental coordination disorder: The role of peer relations self-concept perceptions. *OTJR: Occupation, Participation and Health, 28*, 30-39. doi: 10.3928/15394492-20080101-05

Schoemaker, M. M., Flapper, B., Verheij, N. P., Wilson, B. N., Reinders-Messelink, H. A., & De Kloet, A. (2006). Evaluation of the developmental coordination disorder questionnaire as a screening instrument. *Developmental Medicine & Child Neurology, 48*, 668-673. doi: 10.1111/j.1469-8749.2006.tb01337

Schmidt, M., Blum, M., Valkanover, S., & Conzelmann, A. (2015). Motor ability and self-esteem: The mediating role of physical self-concept and perceived social acceptance. *Psychology of Sport and Exercise, 17*, 15-23. doi: 10.1016/j.psychsport.2014.11.006

Schmidt, R. A., & Wrisberg, C. A. (2000). *Motor learning and performance: A problem-based learning approach, 2nd edition.* Champagne, IL: Human Kinetics.

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

Shute, V. J. (2008). Focus on formative feedback. *Review of Educational Research, 78*, 153-189. doi: 10.3102/0034654307313795

Smits-Engelsman, B., Schoemaker, M., Delabastita, T., Hoskens, J., & Geuze, R. (2015). Diagnostic criteria for DCD: Past and future. *Human Movement Science, 42*, 293-306. doi: 10.1016/j.humov.2015.03.010

Smits-Engelsman, B. C., Blank, R., Van der Kaay, A. C., Mosterd-Van der Meijs, R., Vlugt-Van den Brand, E., Polatajko, H. J., & Wilson, P. H. (2013). Efficacy of interventions to improve motor performance in children with developmental coordination disorder: A combined systematic review and meta-analysis. *Developmental Medicine & Child Neurology, 55*, 229-237. doi: 10.1111/dmcn.12008

Sonstroem, R. J., Harlow, L. L., & Josephs, L. (1994). Exercise and self-esteem: Validity of model expansion and exercise associations. *Journal of Sport and Exercise Psychology, 16*, 29-42.

Stodden, D. F., Goodway, J. D., Langendorfer, S. J., Roberton, M. A., Rudisill, M. E., Garcia, C., & Garcia, L. E. (2008). A developmental perspective on the role of the motor skill competence in physical activity: An emergent relationship. *Quest, 60*, 290-306. doi: 10.1080/00336297.2008.10483582

Sullivan K. J., Kantak, S. S., Burtner, P. A. (2008). Motor learning in children: Feedback effects on skill acquisition. *Physical Therapy, 88*, 720-732. doi: 10.2522/ptj.20070196

Thornton, A., Licari, M., Reid, S., Armstrong, J., Fallows, R., & Elliott, C. (2016). Cognitive orientations to (daily) occupational performance intervention leads to improvements in impairments, activity and participation in children with developmental coordination disorder. *Disability and Rehabilitation, 38,* 979-986. doi: 10.3109/09638288.2015.1070298

Vaivre-Douret, L., Lalanne, C., Ingster-Moati, I., Boddaert, N., Cabrol, D., Dufier, JL., Golse, B., & Falissard, B. (2011). Subtypes of developmental coordination disorder: Research on their nature and etiology. *Developmental Neuropsychology, 36*, 614-643. doi: 10.1080/87565641.2011.560696

Veerman, J. W., Straathof, M. A. E., Treffers, P. D. A., Van den Bergh, B., & Ten Brink, L. T. (1997). *Handleiding Competentiebelevingsschaal voor Kinderen (CBSK) (Manual for the Dutch version of the SPPC)*. Lisse, The Netherlands: Swets & Zeitlinger.

Voerman, L., Korthagen, F. A. J., Meijer, P. C., & Simons, R. J. (2014). Feedback revisited: Adding perspectives based on positive psychology. Implications for theory and classroom practice. *Teaching and Teacher Education, 10*, 91-98. doi: 10.1016/j.tate.2014.06.005

Voerman, L., Meijer, P. C., Korthagen, F. A. J., & Simons, R. J. (2012). Types and frequencies of feedback interventions in classroom interaction in secondary education. *Teaching and Teacher Education, 28*, 1107-1115. doi: 10.1016/j.tate.2012.06.006

Volman, M. J. M. (2009, June). *"How Am I Doing", A new pictorial scale for perceived athletic competence for children aged 6 to 12 years.* Poster session presented at the VIII International Conference on DCD, Baltimore, USA.

Wilson, P. H., Ruddock, S., Smits-Engelsman, B., Polatajko, H., & Blank, R. (2013). Understanding performance deficits in developmental coordination disorder: A meta-analysis of recent research. *Developmental Medicine & Child Neurology, 55*, 217-228. doi: 10.1111/j.1469-8749.2012.04436.x

Wu, S. K., Lin, H. H., Li, Y. C., Tsai, C. L., & Cairney, J. (2010). Cardiopulmonary fitness and endurance in children with developmental coordination disorder. *Research in Developmental Disabilities, 31*, 345-349. doi: 10.1016/j.ridd.2009.09.018

Wuang, Y. P., Su, J. H., & Su, C. Y. (2012). Reliability and responsiveness of the movement assessment battery for children-second edition test in children with developmental coordination disorder. *Developmental Medicine & Child Neurology, 54*, 160-165. doi: 10.1111/j.1469-8749.2011.04177.x

Zwicker, J. G., Missiuna, C., Harris, S. R., & Boyd, L. A. (2012). Developmental coordination disorder: A review and update. *European Journal of Paediatric Neurology, 16*, 573-581. doi: 10.1016/j.ejpn.2012.05.005

Supplementary material

Supplementary Table S4.1 Differences between children with pDCD and typically developing children at baseline, after 12 treatment sessions, and at 3-month follow-up

	Children with pDCD *M* (*SD*)	Typically developing children *M* (*SD*)	Sig.
PAC T0	15.6 (4.3)	19.5 (2.9)	< .001
PAC T1	18.5 (3.8)	19.5 (2.9)	.200
PAC T2	18.1 (3.9)	19.5 (2.9)	.049
GSW T0	19.3 (3.1)	21.2 (2.5)	.001
GSW T1	20.7 (3.2)	21.2 (2.5)	.564
GSW T2	21.1 (2.5)	21.2 (2.5)	.825
PFMC T0	13.1 (2.9)	15.5 (2.3)	< .001
PFMC T1	14.1 (2.8)	15.5 (2.3)	.016
PFMC T2	14.6 (2.4)	15.5 (2.3)	.092
PBC T0	8.3 (1.9)	9.0 (1.4)	.088
PBC T1	9.5 (1.7)	9.0 (1.5)	.101
PBC T2	9.4 (1.3)	9.0 (1.5)	.254
PGMC T0	17.1 (2.5)	17.8 (1.7)	.286
PGMC T1	17.2 (2.1)	17.8 (1.7)	.141
PGMC T2	17.6 (1.9)	17.8 (1.7)	.631
FMTV T0	15.3 (3.1)	15.9 (2.1)	.430
FMTV T1	15.6 (2.7)	15.9 (2.1)	.973
FMTV T2	16.0 (3.4)	15.9 (2.1)	.156
BTV T0	8.8 (1.9)	8.4 (1.8)	.242
BTV T1	9.0 (2.3)	8.4 (1.8)	.183
BTV T2	8.9 (2.2)	8.4 (1.8)	.219
GMTV T0	16.4 (2.7)	15.7 (2.1)	.195
GMTV T1	16.1 (2.1)	15.7 (2.1)	.403
GMTV T2	15.8 (2.7)	15.7 (2.1)	.532
PA T0	9184 (2307)	12214 (2704)	< .001
PA T1	9763 (2655)	12214 (2704)	< .001
PA T2	9457 (2614)	12214 (2704)	< .001
LPA T0	.19 (.11)	.33 (.14)	< .001
LPA T1	.23 (.13)	.33 (.14)	.003
LPA T2	.25 (.14)	.33 (.14)	.019

Note. PFMC = perceived fine motor competence; PBC = perceived ball competence; PGMC = perceived gross motor competence; FMTV = fine motor task values; BTV = ball task values; GMTV = gross motor task values; PAC = perceived athletic competence; GSE = global self-esteem; PA = physical activity; LPA = leisure physical activity; T0 = baseline; T1 = after 12 treatment sessions; T2 = 3-month follow-up.

Supplementary Table S4.2 Differences between children with pDCD in the intervention group, children with pDCD in the care as usual group, and typically developing children at baseline, after 12 treatment sessions, and 3-month follow-up

	Intervention *M* (*SD*)	Care as usual *M* (*SD*)	Typically developing children *M* (*SD*)	Sig.
PAC T0	14.8 (4.3)[a]	17.1 (4.0)[b]	19.5 (2.9)[a, b]	< .001
PAC T1	17.9 (3.6)[a]	19.7 (4.1)	19.5 (2.9)[a]	.119
PAC T2	17.5 (4.2)[a]	19.2 (3.3)	19.5 (2.9)[a]	.083
GSW T0	19.1 (2.8)[a]	19.8 (3.7)	21.2 (2.5)[a]	.003
GSW T1	20.3 (3.6)	21.5 (2.3)	21.2 (2.5)	.635
GSW T2	21.1 (2.5)	21.3 (2.6)	21.2 (2.5)	.931
PFMC T0	13.1 (2.4)[a]	13.0 (3.7)[b]	15.5 (2.3)[a, b]	< .001
PFMC T1	14.7 (2.3)	13.1 (3.4)[b]	15.5 (2.3)[b]	.023
PFMC T2	14.8 (2.6)	14.4 (2.2)	15.5 (2.3)	.191
PBC T0	8.1 (2.0)	8.8 (1.8)	9.0 (1.5)	.091
PBC T1	9.7 (1.8)	9.4 (1.5)	9.0 (1.5)	.227
PBC T2	9.4 (1.3)	9.5 (1.5)	9.0 (1.5)	.517
PGMC T0	16.3 (2.5)[a, c]	18.7 (1.56)[c]	17.8 (1.7)[a]	.003
PGMC T1	17.0 (2.0)	17.7 (2.2)	17.8 (1.7)	.184
PGMC T2	17.5 (2.0)	17.7 (2.0)	17.8 (1.7)	.857
FMTV T0	15.4 (2.9)	15.3 (3.5)	15.9 (2.1)	.731
FMTV T1	16.0 (2.0)	15.0 (3.8)	15.9 (2.1)	.943
FMTV T2	16.4 (2.9)	15.4 (4.3)	15.9 (2.1)	.253
BTV T0	9.0 (1.9)	8.4 (2.0)	8.4 (1.8)	.361
BTV T1	9.1 (2.3)	8.7 (2.4)	8.4 (1.8)	.369
BTV T2	8.7 (2.3)	9.4 (2.1)	8.4 (1.8)	.317
GMTV T0	15.9 (2.2)	17.2 (3.3)	15.7 (2.1)	.177
GMTV T1	16.1 (2.1)	16.1 (2.3)	15.7 (2.1)	.698
GMTV T2	15.8 (2.5)	15.9 (3.2)	15.7 (2.1)	.801
PA T0	9607 (2280)[a]	8340 (2233)[b]	12214 (2704) [a, b]	< .001
PA T1	10161 (2686)[a]	8968 (2551)[b]	12214 (2704) [a, b]	< .001
PA T2	9870 (2734)[a]	8770 (2390)[b]	12214 (2704) [a, b]	< .001
LPA T0	.22 (.12)[a, c]	.13 (.07)[b, c]	.33 (.14)[a, b]	< .001
LPA T1	.22 (.12)[a]	.24 (.15)	.33 (.14)[a]	.012
LPA T2	.28 (.16)	.20 (.10)[b]	.33 (.14)[b]	.025

Note. [a] Groups are significantly different from each other ($p < .05$); [b] Groups are significantly different from each other ($p < .05$); [c] Groups are significantly different from each other ($p < .05$). PFMC = perceived fine motor competence; PBC = perceived ball competence; PGMC = perceived gross motor competence; FMTV = fine motor task values; BTV = ball task values; GMTV = gross motor task values; PAC = perceived athletic competence; GSE = global self-esteem; PA = physical activity; LPA = leisure physical activity; T0 = baseline; T1 = after 12 treatment sessions; T2 = 3-month follow-up.

Chapter 5

Perceived athletic competence and physical activity in children with developmental coordination disorder who are clinically referred, and control children

Johannes J. Noordstar
Ilse Stuive
Hester Herweijer
Lian Holty
Chantal Oudenampsen
Marina M. Schoemaker
Heleen A. Reinders-Messelink

Research in Developmental Disabilities (2014), 35, 3591-3597

Acknowledgement of authors' contributions:
I.S., H.H., L.H., C.O., M.M., and H.R-M designed the study; H.H., L.H., C.O., and H.R-M gathered the data; J.N., I.S., M.M., and H.R-M. performed the data-analysis; J.N., I.S., M.S., and H.R-M wrote the paper.

Abstract

The relationship between perceived athletic competence (PAC) and physical activity (PA) in children with Developmental Coordination Disorder (DCD) is still unclear. This study investigated differences in PAC and PA *between*, and *within*, a group of children with DCD that were clinically referred ($n = 31$) and a group of control children ($n = 38$), aged 7–12 years. All children were categorized in four groups: (a) children with DCD/low PAC, (b) children with DCD/normal to high PAC, (c) control children/low PAC, and (d) control children/normal to high PAC. PAC was assessed with the Self-Perception Profile for Children, and PA was assessed with the Modifiable Activity Questionnaire. Children with DCD participated less in unorganized PA, but not in organized PA, compared with control children. Normal to high PAC was found in more than half of the children with DCD (64.5%). Children with DCD/low PAC and children with DCD/normal to high PAC participated significantly less in unorganized physical activity compared with control children/normal to high PAC, but not compared with control children/low PAC. The results indicate that there are large individual differences in PAC in children with DCD.

Introduction

A fair amount of school-aged children experience difficulties in learning and/or performing motor activities. Children can be diagnosed with Developmental Coordination Disorder (DCD) when motor performance is substantially below that expected given the child's chronological age and previous opportunities for skill acquisition. Also, these difficulties have to significantly interfere with activities in daily life and/or academic achievement and are not due to a medical condition (American Psychiatric Association [DSM-V], 2013). The prevalence of DCD is estimated around 5–6% in school-aged children, where boys are overrepresented compared with girls (Blank, Smits-Engelsman, Polatajko, & Wilson, 2012). Children with DCD experience difficulties in performing motor activities that, in turn, cause difficulties in participation in daily life (e.g., physical activity).

Participation in physical activity is essential for social interaction and life satisfaction in children. Also, physical activity reduces the prevalence of overweight (Dupuy, Godeau, Vignes, & Ahluwalia, 2011; Tudor-Locke, Craig, Cameron, & Griffiths, 2011). Children with DCD participate less in social (Sylvestre, Nadeau, Charron, Larose, & Lepage, 2013) and physical activities (Baerg et al., 2011; Cairney et al., 2005; Cairney, Hay, Veldhuizen, Missiuna, & Faught, 2010) compared with their typically developing peers. These differences in physical activity are present in both unorganized and organized physical activity, and remain roughly the same over time in boys (Cairney et al., 2010).

An important determinant whether children are physically active is perceived athletic competence (Anderson, Masse, Zhang, Coleman, & Chang, 2009; Crocker, Eklund, & Kowalski, 2000; Fisher et al., 2011). Perceived athletic competence is the way children perceive their sports ability and athletic performance (Harter, 1982; Raustorp, Stahle, Gudasic, Kinnunen, & Mattsson, 2005; Ridgers, Fazey, & Fairclough, 2007). Children with DCD have a lower perceived athletic competence compared with their typically developing peers (Cocks, Barton, & Donelly, 2009; Poulsen, Ziviani, & Cuskelly, 2008; Skinner & Piek, 2001). Harter's Competence Motivation theory provides a theoretical framework for explaining the association between perceived athletic competence and physical activity (Harter, 1981). The Competence Motivation theory assumes that children with high perceived competence in a specific domain are more intrinsically motivated to participate in this specific domain, while children with low perceived competence are less motivated.

Cairney et al. (2005) argue that differences in physical activity between children with probable DCD and their typically developing peers are mainly due to the difference in perceived athletic competence. The authors used two models to predict physical activity in children with probable DCD and typically developing children. The first model tested direct effects of probable DCD status (*yes*/*no*) and perceived athletic competence on physical activity, while the second model tested both a direct effect of probable DCD status on physical activity and an indirect effect of probable DCD status on physical activity via perceived athletic competence. The second model fitted the data best indicating that the effect of probable DCD status on physical activity was mediated through perceived athletic competence. Hence, the direct effect between probable DCD status on physical activity became non-significant in the second model (Cairney et al., 2005).

Most studies solely use the criterion of having low motor performance to categorize children as having DCD. In fact, children are even considered as having *probable DCD* if they solely score below cut-off points on motor performance tests. Few studies have used children who meet *all* criteria for DCD and are clinically referred, to investigate physical activity and perceived athletic competence. Investigating differences in physical activity and perceived athletic competence between children with DCD that are clinically referred and their typically developing peers provides vital information for future intervention programs to promote physical activity in children with DCD.

We used the same set of children who participated in the study by Oudenampsen et al. (2013). Those authors investigated differences in physical activity between children with DCD and case-control children, and its relationship with aerobic fitness. However, for the present study, we excluded children who were diagnosed with DCD solely based on low scores on manual dexterity from further analysis because no relationship is expected between manual dexterity, perceived athletic competence, and/or physical activity (Piek, Baynam, & Barrett, 2006). Therefore, we first investigated if differences in unorganized and organized physical activity were still present after removal of the children that were diagnosed with DCD solely based on manual dexterity. Then, we investigated differences in perceived athletic competence between children with DCD and control children. Next, we categorized children based on DCD status (*yes*/*no*) and perceived athletic competence status (*normal to high*/*low*) resulting in four groups: (a) DCD/low perceived athletic competence, (b) DCD/normal to high perceived athletic competence, (c) control/low perceived athletic competence, and (d) control/normal to high perceived athletic competence. Subsequently, we investigated differences in total physical activity, unorganized physical activity, and organized physical activity between the four groups.

We expect children with DCD to participate less in total physical activity, unorganized physical activity, and organized physical activity after removal of the children that were diagnosed with DCD solely based on manual dexterity. Also, we hypothesize that children with DCD have lower perceptions of their athletic competence compared with control children. Because perceived athletic competence is argued to be an important determinant for physical activity we expect perceived athletic competence to have a mediating effect on the relationship between DCD status and physical activity. Therefore, we expect to find differences between the four groups with the exception of the groups DCD/normal to high perceived athletic competence and control/low perceived athletic competence.

Methods

Participants

The present study was part of a multi-centre case-control study in which three rehabilitation centres in the Netherlands participated. Ethical approval was obtained from the Medical Ethics Committee (METC) of the University Medical Center Groningen.

Children with DCD aged 7–12 years were included when diagnosed by a physician according to all DSM-IV criteria.[1] The four DSM-IV criteria were fulfilled when: (a) the total score on the Movement Assessment Battery for Children (M-ABC) (Henderson, Sugden, & Barnett, 1992) was ≤ 15th percentile and/or a subscale score was ≤ 5th percentile, (b) children experienced difficulties in daily life because of problems in motor performance, and (c) no underlying neurological disorders were present. Also, intellectual functioning was checked with an IQ-test. Only children with total IQ scores above 70 were included. We excluded children who scored solely ≤ 5th percentile on the subscale manual dexterity of the M-ABC.

Age and sex matched case-control children were selected from schools for regular education. Motor performance of the control children was also tested with the M-ABC. Children were included when total scores were > 15th percentile and all three subscale scores were > 5th percentile. Written informed consent was received from parents and all children gave verbal assent.

1 At the time of this study the DSM-V was not yet available.

Measurements

Movement Assessment Battery for Children (M-ABC; Henderson et al., 1992)

The M-ABC was used to measure motor performance. The M-ABC is suitable for children between 4 and 12 years of age. The test consists of three subscales: (a) manual dexterity, (b) ball skills, and (c) balance. A summation of the scores on the three subscales gives a total score, which represents the child's general motor performance. Age related normative percentiles scores are available and used in this study. A higher percentile score indicates a better motor performance. Scores > 15^{th} percentile are regarded as a normal motor performance. Scores between 5^{th} and 15^{th} percentile are considered "at risk" for motor problems and scores ≤ 5^{th} indicate significant motor problems. Reliability of the test is good (Smits-Engelsman, Fiers, Henderson, & Henderson, 2008).

Self-Perception Profile for Children (SPPC; Veerman, Straathof, Treffers, van den Bergh, & ten Brink, 1997)

The Dutch version of the SPPC was used to measure perceived athletic competence. This scale consists of 36 questions divided over six subscales. In this study we used only the subscale *perceived athletic competence*. Each question consists of two contradictory quotes. The child has to choose which quote describes him best. For example: 'some kids are really good at sports' or 'other kids are not so good at sports'. After choosing one of the quotes, the child has to indicate whether this was either 'a little bit true for me' or 'totally true for me'. The total score per subscale ranges between 6 and 24 points. A higher score indicates a higher perceived athletic competence. Children scoring ≤ 15^{th} percentile are considered having a low perceived athletic competence. The scale is suitable for children between 8 and 12 years of age and has good validity and reliability (Veerman et al., 1997).

Modifiable Activity Questionnaire (MAQ; Aaron et al., 1993)

The Dutch translation of the MAQ was used to measure participation in physical activity. The questionnaire consists of a number of physical activities, like basketball, cycling, soccer, dance, etc. Children were asked in which of the activities they had participated over the past 12 months. Next, children were asked how many days, and minutes per day, they had participated in that particular activity. Activities performed at least 10 times in the past 12 months were considered as participation in physical activity. Parents assisted the child with the questionnaire. Total physical activity (hours/week) was calculated, as described in Oudenampsen et al. (2013), as follows: (months)*(4.3 weeks/months)*(days/week)*(min/day)/(60 min/hour)/(52 wk/years). We divided total physical activity in *unorganized physical* *activity*, like bicycling and playing soccer during leisure time, and *organized physical activity*, defined as participation through a formal club. The MAQ is a valid instrument to investigate past-year physical activity (Vuillemin et al., 2000).

Data analysis

We first excluded children that were diagnosed with DCD solely based on manual dexterity (n = 7). We did not exclude the seven case-control children because our main research question considers differences between the four groups of children. We did, however, check differences in total physical activity, unorganized physical activity, and organized physical activity between the children diagnosed with DCD solely based on manual dexterity and the other children with DCD, and between the children diagnosed with DCD solely based on manual dexterity and the control children. Then, we computed Shapiro-Wilk tests to investigate data distribution of all variables. Because none of the variables showed a normal distribution of the data, we used Mann-Whitney U tests to investigate differences in total physical activity, unorganized physical activity, organized physical activity, and perceived athletic competence between children with DCD and control children. Next, we categorized children as having low perceived athletic competence (≤ 15^{th} percentile) or having normal to high perceived athletic competence (> 15^{th} percentile). Subsequently, we investigated, using the Chi-square test, if the number of children with low perceived athletic competence was significantly different between children with DCD and control children. Finally, we created four groups of children: (a) DCD/low perceived athletic competence, (b) DCD/normal to high perceived athletic competence, (c) control children/low perceived athletic competence, and (d) control children/normal to high perceived athletic competence. We used Kruskall-Wallis tests to investigate differences in total physical activity, unorganized physical activity, and organized physical activity between groups. When significant, we performed Mann-Whitney U tests to further examine differences between groups. All analyses were performed using SPSS 20.0 for Windows. The statistical significance was set to $p < .05$.

Results

Description of participants

A total of 38 children (10 girls/28 boys) with DCD that were clinically referred and 38 case-control children matched for age and sex participated in this study. As mentioned earlier, children who were diagnosed with DCD solely on low scores for manual dexterity were excluded for further analysis (n = 7). We found that children diagnosed with DCD solely on low scores for manual dexterity participated significantly more in total physical activity, U (n = 38) = 35.00, p = .006, unorganized physical activity, U (n = 38) = 36.00, p = .006, and organized physical activity, U (n = 38) = 42.00, p = .012, compared with the other children with DCD. In fact, although not statistically significant, there was a trend that children diagnosed with DCD solely on low scores for manual dexterity participated more in total physical activity, U (n = 45) = 76.00, p = .074, unorganized physical activity, U (n = 45) = 78.50, p = .088, and organized physical activity, U (n = 45) = 71.00, p = .052, compared with control children as well. This indicates that, as hypothesized earlier, participation in physical activity is not negatively influenced in children diagnosed with DCD solely on low scores for manual dexterity.

Therefore, the final sample used in this study consisted of 31 children (9 girls/22 boys) with DCD that were clinically referred and 38 control children (10 girls/28 boys). Age ranged between 7 and 12 years. Child characteristics are described in Table 5.1.

Table 5.1 Differences between children with DCD and control children

	DCD n = 31	Control children n = 38	Sig.
Gender (boys/girls)	22/9	28/10	
Mean age years (*SD*)	8.45 (1.23)	8.55 (1.31)	.778
Mean weight in kg (*SD*)	34.55 (12.14)	32.56 (7.56)	.952
Height in centimetres (*SD*)	136.90 (9.49)	137.96 (10.73)	.484
Physical activity (hours/week)			
Unorganized physical activity	2.10 (1.62)	4.05 (2.48)	< .001
Organized physical activity	1.30 (0.86)	1.72 (1.28)	.196
Total physical activity	3.41 (1.88)	5.77 (2.75)	< .001
Motor performance (≤ 5th / 5th – 15th / > 15th)			
Manual dexterity	14 / 10 / 7	0 / 3 / 35	
Ball skills	16 / 7 / 8	0 / 3 / 35	
Balance	22 / 4 / 5	0 / 0 / 38	
Total score	26 / 5 / 0	0 / 0 / 38	
Perceived athletic competence			
Low (≤ 15th percentile)	11	5	
High (> 15th percentile)	20	33	

Note. DCD = children with developmental coordination disorder.

Differences in physical activity and perceived athletic competence

Children with DCD participated significantly less in total physical activity compared with control children, U (n = 69) = 301.00, p < .001. We then divided total physical activity in unorganized physical activity and organized physical activity. This revealed that children with DCD participated significantly less in unorganized physical activity, U (n = 69) = 314.50, p < .001, but not in organized physical activity, U (n = 69) = 482.00, p = .196, compared with control children (Table 5.1). These results are comparable to those of Oudenampsen et al. (2013) where all 38 children with DCD were compared with the control children. No significant difference was found for perceived athletic competence scores between children with DCD and control children, U (n = 69) = 478.50, p = .180.

Categorizing motor performance and perceived athletic competence

Next, we investigated individual differences in perceived athletic competence within the group of children with DCD and the group of control children. Twenty children with DCD had normal to high perceptions of their athletic competence (64.5%), while the other eleven children with DCD had low perceptions of their athletic competence (35.5%). Also, thirty-three control children had high perceptions of their athletic competence (86.8%), while the other five control children had low perceptions of their athletic competence (13.2%) (see Table 5.1). The Chi-square test revealed that low perceptions of athletic competence appeared more often in children with DCD than in control children, χ^2 (1, n = 69) = 4.78, p = .029.

Differences between four groups: DCD and perceived athletic competence combined

The main effect of group was significant for total physical activity, H (3, n = 69) = 12.79, p = .005, and unorganized physical activity, H (3, n = 69) = 11.66, p = .009, but not for organized physical activity, H (3, n = 69) = 2.14, p = .544 (see Table 5.2). Post-hoc Mann-Whitney U tests revealed that control children/normal to high perceived athletic competence participated significantly more in total physical activity compared with children with DCD/low perceived athletic competence, U (n = 44) = 77.00, p = .005, and DCD/normal to high perceived athletic competence, U (n = 53) = 170.00, p = .003. Also, control children/normal to high perceived athletic competence participated significantly more in unorganized physical activity compared with children with DCD/low perceived athletic competence, U (n = 44) = 85.50, p = .009, and children with DCD/normal to high perceived athletic competence, U (n = 53) = 171.50, p = .004 (see Table 5.2).

Table 5.2 Differences in physical activity between categories of children

	DCD / low PAC (n = 11) Mean (SD)	DCD / normal to high PAC (n = 20) Mean (SD)	Control / low PAC (n = 5) Mean (SD)	Control / normal to high PAC (n = 33) Mean (SD)	Sig.
Physical activity (hours/week)					
Unorganized physical activity	2.07 (1.07)[a]	2.12 (1.88)[b]	3.45 (3.19)	4.14 (2.40)[a, b]	.009
Organized physical activity	1.35 (0.93)	1.28 (0.84)	1.75 (0.85)	1.71 (1.34)	.544
Total physical activity	3.42 (1.32)[a]	3.40 (2.16)[b]	5.21 (3.24)	5.85 (2.72)[a, b]	.005

Note. DCD = children with developmental coordination disorder; PAC = perceived athletic competence; control = control children.
[a] Groups are significantly different from each other ($p < .05$); [b] Groups are significantly different from each other ($p < .05$).

Discussion

As hypothesized, children with DCD who are clinically referred participated less in total physical activity compared with control children. These results are in line with those reported in other studies investigating physical activity in children with DCD (Baerg et al., 2011; Cairney et al., 2005; Cairney et al., 2010). When we divided total physical activity in unorganized physical activity and organized physical activity, children with DCD participated less in unorganized physical activity, but, unexpectedly, not in organized physical activity. Cairney et al. (2010) found children with probable (but not clinically confirmed) DCD to be less physically active in both free play physical activity and organized physical activity compared with control children. They categorized children as having probable DCD based on a motor performance assessment only. The authors did not investigate if the children with probable DCD experienced any problems in their daily activities as required by criterion B of the DSM-V definition for DCD. In our study we included only children with DCD who met *all* criteria for DCD and were referred for treatment. Therefore, the parents of these children are probably more aware of their child's motor performance problems. Often parents will, or are advised to, enhance their child's motor performance by participating in organized physical activities. This could explain why we did not find any differences in organized physical activity between children with DCD and control children.

Unexpectedly, we found no significant difference in perceived athletic competence between children with DCD and control children while other studies did (Cocks et al., 2009; Poulsen et al., 2008; Skinner & Piek, 2001). In our study a large number of children with DCD had high perceptions of their athletic competence. In the Netherlands most children diagnosed with DCD receive pediatric physical therapy (or pediatric occupational therapy or pediatric exercise therapy). Pediatric physical therapists often give positive feedback during treatment to motivate children. Unfortunately, we did not investigate if, and for how long, children with DCD received pediatric physical therapy. But being a clinically referred group of children it is likely that a fair number would have been referred to a pediatric physical therapist. If children with DCD received pediatric physical therapy for a substantial period of time this might have increased their perceived athletic competence. This would explain why such a large number of children with DCD had high perceptions about their athletic competence.

We then divided children over the four groups and hypothesized differences in physical activity between all groups with the exception of children DCD/normal to high perceived athletic competence and control children/low perceived athletic competence. We expected high perceived athletic competence to compensate for motor problems in children with DCD, making them just as physically active as control children with low perceptions of athletic competence. Our hypothesis was partly correct. Total physical activity and unorganized physical activity was not significantly different between children with DCD/normal to high perceived athletic competence and control children/low perceived athletic competence. However, this was not due to more participation in physical activity in children with DCD/normal to high perceived athletic competence, but caused by less participation in physical activity in control children/low perceived athletic competence. Control children/low perceived athletic competence participated, although not significant, less in total physical activity and unorganized physical activity compared with control children/normal to high perceived athletic competence. Where differences in total physical activity and unorganized physical activity between control children/normal to high perceived athletic competence and the two groups of children with DCD were still significant, differences between control children/low perceived athletic competence and the two groups of children with DCD were no longer significant. The first explanation is the small number of control children/low perceived athletic competence ($n = 5$), which makes it more difficult to find a significant difference between groups. However, secondly, this result indicates that the relationship between perceived athletic competence and physical activity in unorganized physical activity in typically developing children can be explained using Harter's Competence-Motivation theory. In children with DCD this seems not to be the case. Total physical activity and unorganized physical activity was nearly identical in children with DCD/low perceived athletic competence and children with DCD/normal to high perceived athletic competence.

This study has some limitations. Firstly, we did not take into account if any of the children with DCD experienced comorbidity like attention deficit hyperactivity disorder (ADHD) or autism. Studies show large comorbidity with other disorders (Visser, 2003), which might influence both perceived athletic competence and physical activity. Fliers et al. (2010) found children with ADHD to have a poorer motor performance compared with control children, while perceived athletic competence was the same. Also, girls with DCD/ADHD were significantly more physically active compared with control children (Baerg et al., 2011). Secondly, we did not distinguish between boys and girls due to the small number of children. Future research should take gender into account because boys have a higher perceived athletic competence compared with girls in every grade of elementary and middle school (Jacobs, Lanza, Osgood, Eccles, & Wigfield, 2002; Wigfield et al., 1997). Furthermore, boys are more physically active compared with girls in every grade of elementary and middle school (Basterfield et al., 2011; Hearst, Patnode, Sirard, Farbakhsh, & Lytle, 2012). Thirdly, it is generally accepted that physical activity is a construct that is very difficult to measure adequately (Schutz, Weinsier, & Hunter, 2001; Sirard & Pate, 2001). We used a retrospective questionnaire to investigate physical activity. Although the methodological quality of the MAQ has been investigated, methodological quality of retrospective questionnaires are less valid compared with objective measures like pedometers and accelerometers (Chinapaw, Mokkink, Van Poppel, Van Mechelen, & Terwee, 2010).

Clinical implications

Children with DCD participated less in total physical activity and unorganized physical activity compared with control children. Children with DCD had low perceptions of their athletic competence more often than control children. However, we found a large variety of individual differences in perceived athletic competence within the group of children with DCD. Pediatric therapists should be aware of these differences in physical activity and perceived athletic competence. Motor interventions should, therefore, not solely focus on improving motor performance, but also focus on improving motivation for participation in unorganized physical activity.

Conclusion

To conclude, the results of this study add knowledge to the complex relationship between perceived athletic competence and physical activity in children with DCD. We found perceived athletic competence to be very different *within* the group of children with DCD. This indicates that there are other determinants, besides motor performance, that have a strong influence on physical activity in children. To our knowledge, we are the first study to create subgroups between children with DCD and control children based on perceived athletic competence. It seems that the relationship between motor performance, perceived athletic competence, and physical activity is more complex than always assumed. It is, therefore, necessary to investigate this relationship more thoroughly. Future research should investigate the change in, and association between, perceived athletic competence and physical activity longitudinally in children. This change, and association, should be investigated separately for boys and girls, and children with DCD and control children. By doing so, a better understanding about the association between perceived athletic competence and physical activity is obtained.

Acknowledgements

We thank the parents and children who made this research possible. Also, we are grateful to M. v. Hunen for gathering a large part of the data, and prof. dr. M. J. Jongmans for providing feedback on the manuscript.

Highlights

- There are large individual differences in perceptions of athletic competence in children with DCD
- Low perceived athletic competence appears more often in children with DCD than in control children
- Children with DCD participate less in unorganized physical activity than control children

References

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). Washington, DC: American Psychiatric Association.

Aaron, D. J., Kriska, A. M., Dearwater, S. R., Anderson, R. L., Olsen, T. L., Cauley, J. A., & LaPorte, R. E. (1993). The epidemiology of leisure physical activity in an adolescent population. *Medicine & Science in Sports & Exercise, 25*, 847-853. doi: 10.1249/00005768-199307000-00014

Anderson, C. B., Masse, L. C., Zhang, H., Coleman, K. J., & Chang, S. (2009). Contribution of athletic identity to child and adolescent physical activity. *American Journal of Preventive Medicine, 37*, 220-226. doi: 10.1016/j.amepre.2009.05.017

Baerg, S., Cairney, J., Hay, J., Rempel, L., Mahlberg, N., & Faught, B. E. (2011). Evaluating physical activity using accelerometry in children at risk of developmental coordination disorder in the presence of attention deficit hyperactivity disorder. *Research in Developmental Disabilities, 32*, 1343-1350. doi: 10.1016/j.ridd.2011.02.009

Basterfield, L., Adamson, A. J., Frary, J. K., Parkinson, K. N., Pearce, M. S., & Reilly, J. J. (2011). Longitudinal study of physical activity and sedentary behavior in children. *Pediatrics, 127*, e24-30. doi: 10.1542/peds.2010-1935

Blank, R., Smits-Engelsman, B., Polatajko, H., & Wilson, P. (2012). European Academy for Childhood Disability (EACD): Recommendations on the definition, diagnosis and intervention of developmental coordination disorder (long version). *Developmental Medicine & Child Neurology, 54*, 54-93. doi: 10.1111/j.1469-8749.2011.04171.x

Cairney, J., Hay, J. A., Faught, B. E., Wade, T. J., Corna, L., & Flouris, A. (2005). Developmental coordination disorder, generalized self-efficacy toward physical activity, and participation in organized and free play activities. *The Journal of Pediatrics, 147*, 515-520. doi: 10.1016/j.jpeds.2005.05.013

Cairney, J., Hay, J. A., Veldhuizen, S., Missiuna, C., & Faught, B. E. (2010). Developmental coordination disorder, sex, and activity deficit over time: A longitudinal analysis of participation trajectories in children with and without coordination difficulties. *Developmental Medicine & Child Neurology, 52*, e67-72. doi: 10.1111/j.1469-8749.2009.03520.x

Chinapaw, M. J., Mokkink, L. B., Van Poppel, M. N., Van Mechelen, W., & Terwee, C. B. (2010). Physical activity questionnaires for youth: A systematic review of measurement properties. *Sports Medicine, 40*, 539-563. doi: 10.2165/11530770-000000000-00000

Cocks, N., Barton, B., & Donelly, M. (2009). Self-concept of boys with developmental coordination disorder. *Physical & Occupational Therapy in Pediatrics, 29*, 6-22. doi: 10.1080/01942630802574932

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

Dupuy, M., Godeau, E., Vignes, C., & Ahluwalia, N. (2011). Socio-demographic and lifestyle factors associated with overweight in a representative sample of 11-15 year olds in France: Results from the WHO-Collaborative Health Behaviour in School-aged Children (HBSC) cross-sectional study. *BMC Public Health, 11*, 442. doi: 10.1186/1471-2458-11-442

Fisher, A., Saxton, J., Hill, C., Webber, L., Purslow, L., & Wardle, J. (2011). Psychosocial correlates of objectively measured physical activity in children. *European Journal of Public Health, 21*, 145-150. doi: 10.1093/eurpub/ckq034

Fliers, E. A., de Hoog, M. L., Franke, B., Faraone, S. V., Rommelse, N. N., Buitelaar, J. K., & Nijhuis-Van der Sanden, M. W. (2010). Actual motor performance and self-perceived motor competence in children with attention-deficit hyperactivity disorder compared with healthy siblings and peers. *Journal of Developmental & Behavioral Pediatrics, 31*, 35-40. doi: 10.1097/DBP.0b013e3181c7227e

Harter, S. (1981). A model of mastery motivation in children: Individual differences and developmental change. In A. Collins (Eds.), *Minnesota Symposium on Child Psychology* (pp. 215-255). Hillsdale, NJ: Lawrence Erlbaum Associates.

Harter, S. (1982). The perceived competence scale for children. *Child Development, 53*, 87-97. doi: 10.2307/1129640

Hearst, M. O., Patnode, C. D., Sirard, J. R., Farbakhsh, K., & Lytle, L. A. (2012). Multilevel predictors of adolescent physical activity: A longitudinal analysis. *The International Journal of Behavioral Nutrition and Physical Activity, 9*, 8. doi: 10.1186/1479-5868-9-8

Henderson, S. E., & Sugden, D. A. (1992). *Movement assessment battery for children manual.* London: The Psychological Corporation Ltd.

Jacobs, J. E., Lanza, S., Osgood, D. W., Eccles, J. S., & Wigfield, A. (2002). Changes in children's self-competence and values: Gender and domain differences across grades one through twelve. *Child Development, 73*, 509-527. doi: 10.1111/1467-8624.00421

Oudenampsen, C., Holty, L., Stuive, I., Van der Hoek, F., Reinders-Messelink, H., Schoemaker, M., Kottink, A., Van Weert, E., & Buurke, J. (2013). Relationship between participation in leisure time physical activities and aerobic fitness in children with DCD. *Pediatric Physical Therapy*, *25*, 422-429. doi: 10.1097/PEP.0b013e3182a6b6ea

Piek, J. P., Baynam, G. B., & Barrett, N. C. (2006). The relationship between fine and gross motor ability, self-perceptions and self-worth in children and adolescents. *Human Movement Science, 25*, 65-75. doi: 10.1016/j.humov.2005.10.011

Poulsen, A. A., Ziviani, J. M., & Cuskelly, M. (2008). Leisure time physical activity energy expenditure in boys with developmental coordination disorder: The role of peer relations self-concept perceptions. *OTJR: Occupation, Participation and Health, 28*, 30-39. doi: 10.3928/15394492-20080101-05

Raustorp, A., Stahle, A., Gudasic, H., Kinnunen, A., & Mattsson, E. (2005). Physical activity and self-perception in school children assessed with the Children and Youth-Physical Self-Perception Profile. *Scandinavian Journal of Medicine & Science in Sports, 15*, 126-134. doi: 10.1111/j.1600-0838.2004.406.x

Ridgers, N. D., Fazey, D. M., & Fairclough, S. J. (2007). Perceptions of athletic competence and fear of negative evaluation during physical education. *The British Journal of Educational Psychology, 77*, 339-349. doi: 10.1348/026151006X128909

Schutz, Y., Weinsier, R. L., & Hunter, G. R. (2001). Assessment of free-living physical activity in humans: An overview of currently available and proposed new measures. *Obesity Research, 9*, 368-379. doi: 10.1038/oby.2001.48

Sirard, J. R., & Pate, R. R. (2001). Physical activity assessment in children and adolescents. *Sports Medicine, 31*, 439-454. doi: 10.2165/00007256-20131060-00004

Skinner, R. A., & Piek, J. P. (2001). Psychosocial implications of poor motor coordination in children and adolescents. *Human Movement Science, 20*, 73-94. doi: 10.1016/s0167-9457(01)00029-x

Smits-Engelsman, B. C., Fiers, M. J., Henderson, S. E., & Henderson, L. (2008). Interrater reliability of the Movement Assessment Battery for Children. *Physical Therapy, 88*, 286-294. doi: 10.2522/ptj.20070068

Sylvestre, A., Nadeau, L., Charron, L., Larose, N., & Lepage, C. (2013). Social participation by children with developmental coordination disorder compared to their peers. *Disability and Rehabilitation, 35*, 1814-1820. doi: 10.3109/09638288.2012.756943

Tudor-Locke, C., Craig, C. L., Cameron, C., & Griffiths, J. M. (2011). Canadian children's and youth's pedometer-determined steps/day, parent-reported TV watching time, and overweight/obesity: The CANPLAY Surveillance Study. *The International Journal of Behavioral Nutrition and Physical Activity, 8*, 66. doi: 10.1186/1479-5868-8-66

Veerman, J. W., Straathof, M. A. E., Treffers, P. D. A., Van den Bergh, B., & Ten Brink, L. T. (1997). *Handleiding Competentiebelevingsschaal voor Kinderen (CBSK) (Manual for the Dutch version of the SPPC)*. Lisse, The Netherlands: Swets & Zeitlinger.

Visser, J. (2003). Developmental coordination disorder: A review of research on subtypes and comorbidities. *Human Movement Science, 22,* 479-493. doi: 10.1016/j.humov.2003.09.005

Vuillemin, A., Oppert, J. M., Guillemin, F., Essermeant, L., Fontvieille, A. M., Galan, P., . . . Hercberg, S. (2000). Self-administered questionnaire compared with interview to assess past-year physical activity. *Medicine & Science in Sports & Exercise, 32*, 1119-1124. doi: 10.1097/00005768-200006000-00013

Wigfield, A., Harold, R. D., Freedman-Doan, C., Eccles, J. S., Yoon, K. S., Arbreton, A. J., & Blumfield, P. C. (1997). Change in children's competence beliefs and subjective task values across the primary school years: A 3-year study. *Journal of Educational Psychology, 89*, 451-469. doi: 10.1037/0022-0663.89.3.451

Chapter 6

Summary and general discussion

In this chapter we summarize and discuss the results of the studies that are reported in this dissertation. In **PART I** of this dissertation we investigated the change in, and associations between, self-perceptions, task values (i.e., the personal importance a task has for a person), and physical activity in elementary school children over a 2 year period using latent growth curve analyses. We investigated associations between the change (i.e., slopes) in self-perceptions, task values, and physical activity. We also investigated whether these changes, and associations, were different for boys and girls, and for children with motor problems and typically developing children. In **PART II** we investigated the impact of perceived athletic competence on physical activity in children with developmental coordination disorder (DCD), and whether enhancing perceived athletic competence during a motor intervention in children with probable developmental coordination disorder (pDCD) would positively influence participation in physical activity.

Summary

Part I

In **Chapter 2** we examined the change in, and associations between, global self-esteem, perceived athletic competence, and physical activity in children from kindergarten to grade 4. We also investigated whether this change and these associations were different for boys and girls. Two cohorts of children participated in this longitudinal study. Children in cohort I were followed from kindergarten to grade 2, and children in cohort II were followed from grade 2 to grade 4. Global self-esteem and perceived athletic competence were measured with the Self-Perception Profile for Children (SPPC) (n = 292; 148 boys), and physical activity was measured with a 7-day proxy report completed by parents (n = 184; 88 boys). The results showed that global self-esteem, perceived athletic competence, and physical activity remained stable between kindergarten and grade 4. Global self-esteem was the same in boys and girls, while boys reported higher levels of perceived athletic competence and were more physically active than girls. We concluded that there were few developmental changes in global self-esteem, perceived athletic competence, and physical activity from kindergarten to grade 4. The change in global self-esteem was significantly associated with perceived athletic competence and physical activity in girls, but not in boys.

In **Chapter 3** we used the same samples of children as described in Chapter 2 to investigate self-perceptions and task values with regard to motor performance more specifically. We examined the change in, and associations between, self-perceptions and task values on fine motor competence, ball competence, and athletic competence in 292 children (148 boys) from kindergarten to grade 4. Again, we investigated whether there were differences between boys and girls, and also between children with motor problems and typically developing children. Self-perceptions of fine motor competence and athletic competence declined over time, while self-perceptions of ball competence remained stable. Girls perceived their fine motor competence higher than boys, while boys perceived their ball competence higher. Self-perceptions of athletic competence were the same in boys and girls. Task values remained stable over time. Boys valued their ball competence higher than girls, but boys and girls valued their fine motor competence and athletic competence equally. Children with motor problems perceived and valued their motor competence the same as typically developing children. Also, self-perceptions were not associated with task values. We concluded that self-perceptions and task values were domain specific and differ between boys and girls, but not between children with motor problems and typically developing children.

Part II

In **Chapter 4**, we investigated whether an integrated behavioral and motor intervention affects pDCD children's motor performance, self-perceptions, and physical activity more than a motor intervention only (care-as-usual). For this quasi-experimental study, inclusion criteria were: (a) children referred to pediatric physical therapy by a general practitioner or school medical officer, (b) a total score ≤ 16th percentile on a general motor assessment battery (MABC-2), (c) an indication of DCD or suspected DCD as reported by parents on a questionnaire (DCD-Q), (d) a mean score below the advised number of daily steps for children (boys < 15000; girls < 12000) on a pedometer (Yamax CW700), (e) aged between 7 and 10 years old, and (f) no known neurological disorder causing motor problems (e.g., Cerebral Palsy, Spina Bifida). Children were excluded when their total score ≤ 16th percentile on the MABC-2 was the result of a low score on the subscale manual dexterity only. The intervention group consisted of 20 children and the care-as-usual group consisted of 11 children. Pediatric physical therapists who administered the integrated behavioral and motor intervention were trained in providing positive, specific, and progress feedback to enhance self-perceptions during treatment sessions. Children were assessed at baseline, after 12 treatment sessions (trial end-point), and at 3-month follow-up.

There were no differences between the intervention and the care-as-usual group on any of the outcome measures. Children improved their motor performance and increased their perceived athletic competence, global self-esteem, and perceived motor competence after 12 treatment sessions. This improvement was maintained at 3-month follow-up. Motor task values and physical activity remained unchanged for all children. We concluded that an integrated behavioral and motor intervention is as effective as care-as-usual in children with pDCD.

In **Chapter 5** we investigated differences in perceived athletic competence and physical activity between, and within, a group of children with DCD (*n* = 31) and a control group of typically developing children (*n* = 38). Perceived athletic competence was assessed with the Dutch version of the Self-Perception Profile for Children (SPPC), and physical activity with the Modifiable Activity Questionnaire (MAQ). Children with DCD participated less in unorganized physical activity, but not in organized physical activity, than control children. Low perceived athletic competence appeared more often in children with DCD than in control children, but normal to high perceived athletic competence was found in more than half of the children with DCD (64.5%).

We then categorized the children into four groups: (a) children with DCD / low perceived athletic competence, (b) children with DCD / normal to high perceived athletic competence, (c) control children / low perceived athletic competence, and (d) control children / normal to high perceived athletic competence. Children with DCD / low perceived athletic competence and children with DCD / normal to high perceived athletic competence participated significantly less in unorganized physical activity than control children / normal to high perceived athletic competence, but not less than control children / low perceived athletic competence. We concluded that there were large individual differences in perceived athletic competence in children with DCD.

General discussion

Part I

Physical activity and global self-esteem are important, and much investigated, outcomes for pediatric physical therapists and (pediatric) psychologists (e.g., Basterfield et al., 2011; Bauman et al., 2012; Gentile et al., 2009). Participation in physical activity is protective against obesity and essential for social interaction, and global self-esteem is regarded as an important index of well-being and mental health (e.g., Babiss & Gangwisch, 2009; Biddle & Asare, 2011). We used the Exercise and Self-Esteem Model (EXSEM) (Sonstroem, Harlow, & Josephs, 1994) (see Figure 6.1), which hypothesizes positive associations between global self-esteem and physical activity through lower-order self-perceptions (e.g., perceived athletic competence),

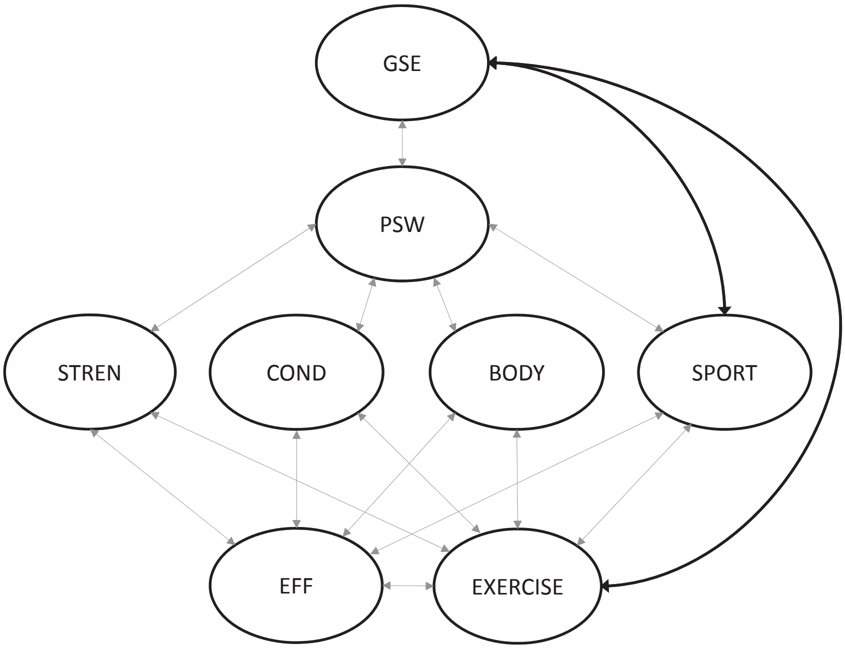


Figure 6.1 The adapted Exercise and Self-Esteem Model (Sonstroem et al., 1994; Sonstroem, 1998). The curved lines represent the significant associations in girls. We found no significant associations in boys. GSE = global self-esteem; PSW = physical self-worth; SPORT = perceived sport competence; COND = perceived physical condition; BODY = perceived attractive body; STREN = perceived physical strength; EFF = self-efficacies; EXERCISE = exercise behavior.

as a theoretical framework to investigate the change in, and associations between, global self-esteem, perceived athletic competence, and physical activity in elementary school children. Our results indicate that global self-esteem, perceived athletic competence, and physical activity remain stable between kindergarten and grade 4. Global self-esteem was the same in boys and girls, while perceived athletic competence and physical activity was higher in boys. This is in line with other studies (e.g., Basterfield et al., 2011; Cole et al., 2001; Jacobs, Lanza, Osgood, Eccles, & Wigfield, 2002; Robins & Trzesniewski, 2005).

To provide vital information for intervention programs to promote physical activity and, in turn, enhance global self-esteem, we were mainly interested in associations between the change in global self-esteem, perceived athletic competence, and physical activity. The change in global self-esteem was associated with perceived athletic competence and physical activity in girls, but not in boys. We speculated that girls are more likely to attribute success to their own ability and failure to a lack of their own ability (internal locus of control), while boys are more likely to attribute success and failure to powerful others or unknown causes (external locus of control) (Wigfield, Battle, Keller, & Eccles, 2002). Worth mentioning is that the association between global self-esteem and physical activity was not significantly different between boys and girls.

We are one of the first to investigate the change in, and associations between, self-perceptions and physical activity in elementary school children, and the first to investigate these associations using latent growth curve analyses. However, with regard to measuring physical activity, we investigated only *after school* physical activity. We were therefore unable to provide a complete picture of the child's physical activity. Also, the validity of activity diaries, which we used to investigate after school physical activity, is argued to be questionable (Chinapaw, Mokkink, Van Poppel, Van Mechelen, & Terwee, 2010). Objectively measured physical activity (e.g., accelerometers) would provide a better, and possibly more valid, picture of the child's physical activity. A more objective measurement would possibly influence associations between global self-esteem, perceived athletic competence, and physical activity.

We have to keep in mind that we did not investigate the full EXSEM. We focused on investigating the change in, and associations between, global self-esteem, perceived athletic competence, and physical activity because we were mainly interested in the associations between perceived athletic competence and physical activity. The full EXSEM hypotheses that global self-esteem is influenced by perceived physical self-worth, which is, besides sport competence (i.e., perceived athletic competence), influenced by the lower-order self-perceptions of body image, condition, and strength. To provide insight into the full EXSEM, we should have investigated the other self-perceptions also.

The Expectancy-Value model (Eccles et al., 1983) was used as a theoretical framework in Chapter 3. In this model associations are hypothesized between self-perceptions and task values. We investigated the change in, and associations between, self-perceptions and task values on fine motor competence, ball competence, and gross motor competence because children need more than just a positive evaluation of their own (general) athletic competence to be motivated to participate in activities in daily life. Our results indicate that different growth curves can be distinguished for self-perceptions on fine motor competence, ball competence, and gross motor competence, while all task values remain stable. There were differences in self-perceptions between boys and girls, but not between children with motor problems and typically developing children. Also, no associations were found between self-perceptions and the corresponding task values. The change in self-perceptions, and differences between boys and girls, were generally as expected beforehand. With regard to the unexpectedly stable task values, we argue that the questions asked to investigate task values consist of activities that are essential for daily life. Children are probably aware that these activities are important in daily life, equally so for boys and girls and children with motor problems and typically developing children, resulting in stable task values. From a statistical perspective, associations between self-perceptions and task values are non-significant because self-perceptions did change from kindergarten to grade 4, while task values did not.

The Expectancy-Value model argues that perceived competence and task values directly influence achievement behavior (Eccles et al., 1983). With hindsight, we should have also investigated this achievement behavior, instead of only investigating the change in, and associations between, perceived motor competence and motor task values. Also, the Expectancy-Value model distinguishes four motivational components of (subjective) task values, while we only investigated one of these components: attainment value. We therefore did not provide a full picture of task values, which possibly influenced our results.

Also, only a small number of children were classified as having motor problems, especially with regard to ball competence and gross motor competence. The proportion of children with motor problems was smaller than expected beforehand. The results of children with motor problems should therefore be interpreted with caution.

Measuring self-perceptions and task values

We investigated the change in self-perceptions and task values on a latent level using a cohort-sequential design. By fitting the growth model on factors instead of scale scores, measurement error at the item level was taken into account by the measurement model (e.g., Preacher, Wichman, MacCallum, & Briggs, 2008). Although using growth curves is fairly common to investigate developmental trajectories (e.g., Jacobs et al., 2002), we are one of the first to use this technique to investigate longitudinal associations between self-perceptions and physical activity. Also, factor loadings on global self-esteem and perceived athletic competence were acceptable when children were in kindergarten and grade 1, meaning that children in kindergarten already have the ability to provide a valid perception about themselves, something that has been argued against in the past (e.g., Harter, 2006).

We used a new instrument, the How Am I Doing questionnaire (Calame et al., 2009), to investigated self-perceptions and task values about fine motor competence, ball competence, and gross motor competence. Therefore, little was known about the psychometric properties. We investigated the factor loadings of the items on the corresponding latent variable, but, unfortunately, the factor loadings were generally low. However, we would argue that our results are still valid because we fitted the growth models on the common factors, which represents the true score part of the observed variable instead of the observed scores (Bollen, 1989). Nevertheless, it is important to mention that the low reliability of the How Am I Doing questionnaire indicates that the observed scores of this questionnaire should not be used to make predictions or decisions at the individual level.

Future research

Future research should investigate whether self-perceptions and task values influence participation in daily activities in the corresponding domain. If they do indeed influence participation in daily activities, our advice to pediatric physical therapists and educators would be to enhance self-perceptions and task values when teaching children new activities.

From a more psychological point of view, we should investigate longitudinal associations between global self-esteem and *all* lower-order self-perceptions (e.g., physical appearance, social acceptance) to provide a full understanding of the change in global self-esteem. Also, we should investigate whether we can distinguish different growth curves of global self-esteem and lower-order self-perceptions (i.e., increase, decline, remain positive, and remain negative) to provide a more precise understanding of these growth curves, something that has been done in adolescents but not (yet) in elementary school children (e.g., Birkeland, Melkevik, Holsen, & Wold, 2012).

Conclusions

In children from kindergarten to grade 4:

- Global self-esteem, perceived athletic competence, and physical activity remain stable. Global self-esteem is the same in boys and girls, while boys have a higher perceived athletic competence and are more physically active than girls.
- The change in perceived athletic competence and physical activity are associated with the change in global self-esteem in girls, but not in boys.
- Perceived fine motor competence and perceived gross motor competence decline, while perceived ball competence remains stable. Girls have a higher perceived fine motor competence, while boys have a higher perceived ball competence. Boys and girls perceive themselves the same for perceived gross motor competence.
- Fine motor task values, ball task values, and gross motor task values remain stable and are not associated with the change in perceived competence. Boys value their ball

competence as higher than girls, but their fine motor competence and gross motor competence the same as girls.

- Children with motor problems perceive and value themselves the same as typically developing children with regard to their fine motor competence, ball competence, and gross motor competence.

Part II

We used the model by Stodden et al. (2008) as the primary framework for our quasi-experimental study (see Figure 6.2). According to this model, perceived motor competence (partially) mediates the association between motor competence (i.e., motor performance) and physical activity. A number of studies provide empirical evidence for positive associations between perceived athletic competence and physical activity in children and adolescents (e.g., Barnett, Morgan, Van Beurden, Ball, & Lubans, 2011; Raudsepp, Neissaar, & Kull, 2013). Cairney et al. (2005) argued that the lower levels of perceived athletic competence are the primary reason for the difference in physical activity between children with pDCD and typically developing children. In our quasi-experimental study, we therefore aimed to enhance children's motor performance and perceived athletic competence in the intervention

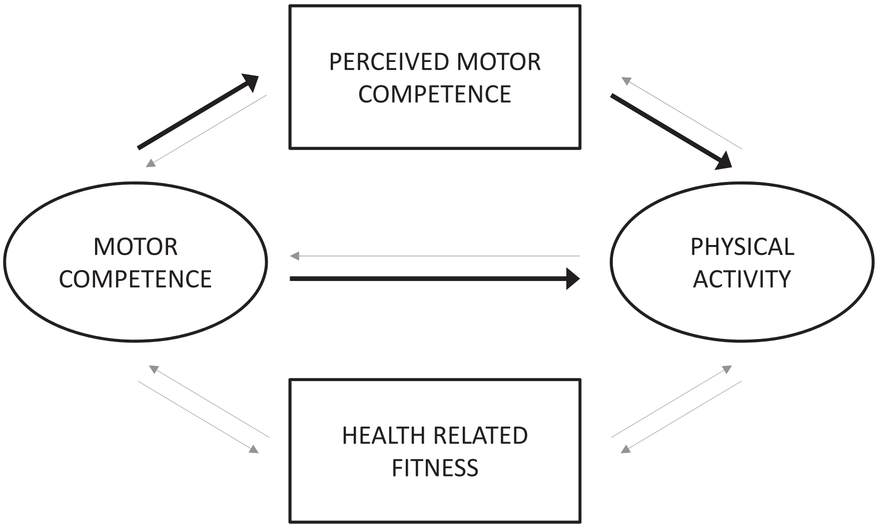


Figure 6.2 The relationship between motor competence and physical activity (adapted from Stodden et al., 2008).
The bold lines represent the paths that we hypothesized for our intervention to enhance physical activity in children with pDCD.

group to improve participation in physical activity. However, our results indicate that this intervention is just as effective as a motor intervention only (care-as-usual) to improve motor performance and self-perceptions (e.g., perceived athletic competence). The improvement in motor performance and perceived athletic competence, as a group, is in line with other studies (Pless, Carlsson, Sundelin, & Persson, 2001; Smits-Engelsman et al., 2013). Physical activity remained the same in both groups during our study period.

Although we found no differences between the intervention and the care-as-usual group, and no improvement in physical activity, we argue that we tapped into a new chapter of research in children with (p)DCD. Intervention studies for children with (p)DCD have focused mainly on the effect on motor performance and concluded that, overall, a task-oriented approach is more effective than a process-oriented approach (e.g., Blank, Smits-Engelsman, Polatajko, & Wilson, 2012; Smits-Engelsman et al., 2013). We are one of the first to also investigate if an intervention for children with (p)DCD is effective on participation in physical activity. The only other study that investigated the effect on physical activity in children with (p)DCD was published only recently. The authors concluded that a 16-week home-based active video game intervention did not improve physical activity and sedentary time in children with DCD (Howie, Campbell, & Straker, 2016). Children with DCD in the intervention group played active video games for 140.3 (62.9) minutes a week, but did not participate more in physical activity, or less in sedentary behavior, than the control group.

Looking back at our intervention study there are several issues that we need to discuss to better understand our results and provide advice for future research. First, there is the issue of the large intra-group variability in children with (p)DCD. We excluded children if their motor difficulties were caused by manual dexterity only, but we did not exclude children who had normal levels of perceived athletic competence. We assumed, based on a number of studies (e.g., Cocks, Barton, & Donelly, 2009; Poulsen, Ziviani, & Cuskelly, 2008; Skinner & Piek, 2001), that children with (p)DCD had low levels of perceived athletic competence. However, we found large intra-group variability with regard to perceived athletic competence in children with pDCD and DCD (**Chapter 4**). Hence, 54.8% of the children with pDCD had already normal levels (> 15th percentile) of perceived athletic competence at baseline. In retrospect, we should have included only children with low perceived athletic competence (≤ 15th percentile) because our invention focused on improving perceived athletic competence, which, in turn, should have affected participation in physical activity. There is presumably also a large intra-group variability in children with pDCD with regard to other determinants of physical activity. Future research should take this intra-group variability into account when designing (randomized) controlled trials.

The small, and insufficient, sample size is a second major issue in our intervention study (we needed 19 children in each group and included 20 children in the intervention and 11 children in the care-as-usual group) and in (randomized) controlled trials with children with (p)DCD in general (e.g., Au et al., 2014; Giagazoglou, Sidiropoulou, Mitsiou, Arabatzi, & Kellis, 2015; Niemeijer, Smits-Engelsman, & Schoemaker, 2007). Large samples of children with (p)DCD are necessary to investigate whether the effect of one intervention surpasses the effect of another intervention because differences in effect size are relatively small. Au et al. (2014) concluded, based on the results of their pilot study, that they needed 426 children with DCD to detect a significant effect of a task-oriented approach on the Bruininks - Oseretsky Test compared with core stability training (process-oriented approach). A number of participants that has (so far) never been achieved in a (randomized) controlled trial in children with (p)DCD (Blank et al., 2012).

Future research

We would like to advocate for a (large) comprehensive practice-based evidence for clinical practice improvement (PBE-CPI) study in children with (p)DCD before new (randomized) controlled trials are conducted. The use of PBE-CPI studies has been opted for before in rehabilitation interventions (Horn & Gassaway, 2007; Kersten, Ellis-Hill, McPherson, & Harrington, 2010; Rosenbaum, 2010; Sussman, 2010). PBE-CPI studies are however still scarce, possibly because randomized controlled trials are still regarded as the 'gold standard' related to intervention studies (Kersten et al., 2010). However, we argue that the use of PBE-CPI studies provides more 'real life', so-called ecologically valid results. In short, PBE-CPI studies are characterized by large databases in which detailed information is provided about: (a) a number of (key) participant characteristics and determinants, (b) the intervention processes, and (c) the results of multiple outcome measurements. Using regression analyses, treatment effects can be compared and important associations between determinants and outcome measures (like physical activity) can be identified.

Conclusions and clinical implications

- Children with pDCD who received positive, specific, progress feedback as described in our intervention did not improve their motor performance, self-perceptions, and physical activity more than the children with pDCD who received feedback that was given in care-as-usual.

- Perceived athletic competence may differ considerable between children with pDCD before motor interventions are initiated, but nevertheless increases in almost all children with pDCD after a motor intervention.
- Physical activity in children with (p)DCD is, overall, significantly lower than in typically developing children. Motor interventions should, therefore, not solely focus on improving motor performance, but also focus on improving participation in physical activity.

Sem revisited

This dissertation started with a clinical scenario that described Sem's improvement after several treatment sessions. Sem is not a unique case to pediatric physical therapists and many may have experienced comparable results in their daily practice. Why was the treatment approach in Sem successful and yet we were unable to show similar results in a trial in which we studied an intervention that was strongly based on the positive experience that we had with Sem?

We were able to increase motor performance and self-perceptions in the study group of children with pDCD. However, unfortunately, we were unable to increase their participation in physical activity. The question now is: Why was I able to increase Sem's participation in physical activity, but why were we unable to increase a group of pDCD children's participation in physical activity?

As I reflect on my treatment sessions with Sem, I think that our positive therapist-client relationship might have been an influential factor that motivated him (and possibly his whole family) to increase participation in physical activity. Other studies have also found that a positive therapist-client relationship positively affects the outcome of physical therapy in adults (see for review Hall, Ferreira, Maher, Latimer, & Ferreira, 2010). Furthermore, Sem had a strong desire to participate in activities with his peers, which was articulated in his 'clinical question': "The wish to improve activities" (e.g., soccer, ball games, climbing) and "Be able to play with his friends". I now think that the positive therapist-client relationship combined with Sem's "strong desire to participate in physical activities with his friends" resulted in a more positive outcome with regard to physical activity than we found in the group of children with pDCD. In our study we did not study the relationship between the "self-defined clinical question" and the goals set by the therapist, nor did we measure the therapist-client relationship. Future studies might well take these elements into account.

From a practical perspective (what should we really do)…

A large number of interventions have tried to enhance physical activity in typically developing children (e.g., Kipping et al., 2014; Nyberg et al., 2015) and a few interventions have tried to enhance physical activity in children with (p)DCD (Au et al., 2015; Zwicker et al., 2014), however, without any real success. A recently published meta-analysis also concluded that there was only a negligible to small effect on improving total physical activity and a small to moderate effect on improving moderate-to-vigorous physical activity in typically developing children (Metcalf, Henley, & Wilkin, 2012).

In our introduction we argued that a possible reason for this (disappointing) result is that many interventions do not take determinants of physical activity into account, like perceived athletic competence. In our studies, however, we found no association between perceived athletic competence and physical activity. We also argued, based on Cairney et al. (2005), that perceived athletic competence was the main reason why children with (p)DCD participated less in physical activity than typically developing children. However, enhancing perceived athletic competence in our intervention group of children with pDCD did not improve their participation in physical activity.

Maybe it is time to stop thinking that we are able to notably increase physical activity in both typically developing children and children with (p)DCD. There are several reasons for this statement. First, physical activity is influenced by a large number of determinants (e.g., Bauman et al., 2012; Craggs, Corder, Van Sluijs, & Griffin, 2011). It is seemingly impossible to enhance all these determinants during an intervention program, let alone take the large inter-individual differences in children into account. Second, an important barrier to participate in sports is costs (Hardy, Kelly, Chapman, King, & Farrell, 2010). Participation in sports can be too expensive for children from low socioeconomic backgrounds, while they are the children that participate least in physical activity (De Vries, Bakker, Van Overbeek, Boer, & Hopman-Rock, 2005). Third, our society is (now) designed in such a way that children are 'forced' to spend a substantial amount of time behind computers, I-phones, and I-pads (e.g., doing homework, being social), resulting in less physically active behavior during the day. Finally, some people just don't like being physically active and will therefore not participate in physical activity at all.

If a society really wants their children to meet international recommendations, physical activity should be embedded in daily routines and needs to be income neutral. School would be a perfect environment to realize this. Though some schools currently have a dedicated physical education teacher and have set aside time for physical education multiple times a week, this practice is not widespread and does not dedicate enough weekly hours to it to meet the international standards. My solution is therefore simple: Physical education for an hour every day! A comparable initiative called 'daily mile' has recently been introduced in an elementary school in the UK (Slawson, 2015). Children, teachers, and parents are very enthusiastic and a comparative study to quantify the effect is on its way. Physical education teachers should still try to enhance children's intrinsic motivation for physical activity (e.g., increase perceived athletic competence). In doing so, some children will also participate in physical activities after school. Those who do not, because they don't like being physically active, will still meet international recommendations for physical activity.

References

Au, M. K., Chan, W. M., Lee, L., Chen, T. M., Chau, R. M., & Pang, M. Y. (2014). Core stability exercise is as effective as task-oriented motor training in improving motor proficiency in children with developmental coordination disorder: A randomized controlled pilot study. *Clinical Rehabilitation, 28*, 992-1003. doi: 10.1177/0269215514527596

Babiss, L. A., & Gangwisch, J. E. (2009). Sports participation as a protective factor against depression and suicidal ideation in adolescents as mediated by self-esteem and social support. *Journal of Developmental and Behavioral Pediatrics, 30*, 376-384. doi: 10.1097/dbp.0b013e3181b33659

Barnett, L. M., Morgan, P. J., Van Beurden, E., Ball, K., & Lubans, D. R. (2011). A reverse pathway? Actual and perceived skill proficiency and physical activity. *Medicine & Science in Sports & Exercise, 43*, 898-904. doi: 10.1249/mss.0b013e3181fdfadd

Basterfield, L., Adamson, A. J., Frary, J. K., Parkinson, K. N., Pearce, M. S., & Reilly, J. J. (2011). Longitudinal study of physical activity and sedentary behavior in children. *Pediatrics, 127*, e24-30. doi: 10.1542/peds.2010-1935

Bauman, A. E., Reis, R. S., Sallis, J. F., Wells, J. C., Loos, R. J., & Martin, B. W. (2012). Correlates of physical activity: Why are some people physically active and others not? *Lancet, 380*, 258-271. doi: 10.1016/s0140-6736(12)60735-1

Biddle, S. J., & Asare, M. (2011). Physical activity and mental health in children and adolescents: A review of reviews. *British Journal of Sports Medicine, 45*, 886-895. doi: 10.1136/bjsports-2011-090185

Birkeland, M. S., Melkevik, O., Holsen, I., & Wold, B. (2012). Trajectories of global self-esteem development during adolescence. *Journal of Adolescence, 35*, 43-54. doi: 10.1016/j.adolescence.2011.06.006

Blank, R., Smits-Engelsman, B., Polatajko, H., & Wilson, P. (2012). European Academy for Childhood Disability (EACD): Recommendations on the definition, diagnosis and intervention of developmental coordination disorder (long version). *Developmental Medicine & Child Neurology, 54*, 54-93. doi: 10.111/j.1469-8749.2011.04171.x

Bollen, K. A. (1989). Structural equations with latent variables. New York: Wiley.

Cairney, J., Hay, J. A., Faught, B. E., Wade, T. J., Corna, L., & Flouris, A. (2005). Developmental coordination disorder, generalized self-efficacy toward physical activity, and participation in organized and free play activities. *The Journal of Pediatrics, 147*, 515-520. doi: 10.1016/j/jpeds.2005.05.013

Calame, E., Reinders, H., Smits, B. C. M., Schoemaker, M. M., Volman, M. J. M., & De Kloet, A. (2009). *Hoe ik vind dat ik het doe vragenlijst: Vragenlijst motorische competentiebeleving (How am I doing questionnaire: A questionnaire to investigate perceived motor competence)*. Unpublished manuscript.

Chinapaw, M. J., Mokkink, L. B., Van Poppel, M. N., Van Mechelen, W., & Terwee, C. B. (2010). Physical activity questionnaires for youth: A systematic review of measurement properties. *Sports Medicine, 40*, 539-563. doi: 10.2165/11530770-000000000-00000

Cocks, N., Barton, B., & Donelly, M. (2009). Self-concept of boys with developmental coordination disorder. *Physical & Occupational Therapy in Pediatrics, 29*, 6-22. doi: 10.1080/01942630802574932

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

Craggs, C., Corder, K., Van Sluijs, E. M., & Griffin, S. J. (2011). Determinants of change in physical activity in children and adolescents: A systematic review. *American Journal of Preventive Medicine, 40*, 645-658. doi: 10.106/j.amepre.2011.02.025

De Vries, S. I., Bakker, I., Van Overbeek, K., Boer, N. D., & Hopman-Rock, M. (2005). Kinderen in prioriteitswijke: Lichamelijke (in)activiteit en overgewicht (TNO-rapport KvL/B&G/2005.197). Retrieved from Nederlandse Organisatie voor toegepast-natuurwetenschappelijk onderzoek TNO, TNO Kwaliteit van Leven: https://www.tno.nl/media/1431/pzsckindereninstadswijkenrapport.pdf

Eccles, J. S., Adler, T. F., Futterman, R., Goff, S. B., Kaczala, C. M., Meece, J. L., & Midgley, C. (1983). Expectancies, values, and academic behaviors. In J. T. Spence (Ed.), *Achievement and achievement motivation* (pp. 77-146). San Fransico, CA: W.H. Freeman.

Gentile, B., Grabe, S., Dolan-Pascoe, B., Twenge, J., Wells, B., & Maitino, A. (2009). Gender differences in domain-specific self-esteem: A meta-analysis. *Review of General Psychology, 13*, 34-45. doi: 10.1037/a0013689

Giagazoglou, P., Sidiropoulou, M., Mitsiou, M., Arabatzi, F., & Kellis, E. (2015). Can balance trampoline training promote motor coordination and balance performance in children with developmental coordination disorder? *Research in Developmental Disabilities, 36*, 13-19. doi: 10.1016/j.ridd.2014.09.010

Hall, A. M., Ferreira, P. H., Maher, C. G., Latimer, J., & Ferreira, M. L. (2010). The influence of the therapist-patient relationship on treatment outcome in physical rehabilitation: A systematic review. *Physical Therapy, 90*, 1099-1110. doi: 10.2522/ptj.20090245

Hardy, L. L., Kelly, B., Chapman, K., King, L., & Farrell, L. (2010). Parental perceptions of barriers to children's participation in organised sport in Australia. *Journal of Paediatrics and Child Health, 46*, 197-203. doi: 10.1111/j.1440-1754.2009.01661.x

Harter, S. (2006). The self. In N. Eisenberg, W. Damon, & R. M. Lerner (Eds.), *Handbook of Child Psychology, 6th Edition, Volume 3: Social, Emotional, and Personality Development* (pp. 505-570). Hoboken, NJ: John Wiley & Sons.

Horn, S. D., & Gassaway, J. (2007). Practice-based evidence study design for comparative effectiveness research. *Medical Care, 45*, S50-57. doi: 10.1097/mlr.0b013e318070c07b

Howie, E. K., Campbell, A. C., & Straker, L. M. (2016). An active video game intervention does not improve physical activity and sedentary time of children at-risk for developmental coordination disorder: A crossover randomized trial. *Child: Care, Health and Development, 42*, 253-260. doi: 10.1111/cch.12305

Jacobs, J. E., Lanza, S., Osgood, D. W., Eccles, J. S., & Wigfield, A. (2002). Changes in children's self-competence and values: Gender and domain differences across grades one through twelve. *Child Development, 73*, 509-527. doi: 10.111/1467-8624.00421

Kersten, P., Ellis-Hill, C., McPherson, K. M., & Harrington, R. (2010). Beyond the RCT - understanding the relationship between interventions, individuals and outcome - the example of neurological rehabilitation. *Disability and Rehabilitation, 32*, 1028-1034. doi: 10.3109/09638281003775568

Kipping, R. R., Howe, L. D., Jago, R., Campbell, R., Wells, S., Chittleborough, C. R., . . . Lawlor, D. A. (2014). Effect of intervention aimed at increasing physical activity, reducing sedentary behaviour, and increasing fruit and vegetable consumption in children: Active for Life Year 5 (AFLY5) school based cluster randomised controlled trial. *BMJ, 348*, g3256. doi: 10.1136/bmj.g3256

Metcalf, B., Henley, W., & Wilkin, T. (2012). Effectiveness of intervention on physical activity of children: Systematic review and meta-analysis of controlled trials with objectively measured outcomes (EarlyBird 54). BMJ, 345, e5888. doi: 10.1136/bmj.e5888

Murphy, G. C., King, N. J., & Ollendick, T. H. (2007). Identifying and developing effective interventions in rehabilitation settings: Recognising the limits of the evidence-based practice approach. *Australian Journal of Rehabilitation Counselling, 13*, 14-19. doi: 10.1375/jcr.13.1.14

Niemeijer, A. S., Smits-Engelsman, B. C., & Schoemaker, M. M. (2007). Neuromotor task training for children with developmental coordination disorder: A controlled trial. *Developmental Medicine & Child Neurology, 49*, 406-411. doi: 10.1111/j.1469-8749.2007.00406.x

Nyberg, G., Sundblom, E., Norman, A., Bohman, B., Hagberg, J., & Elinder, L. S. (2015). Effectiveness of a universal parental support programme to promote healthy dietary habits and physical activity and to prevent overweight and obesity in 6-year-old children: The Healthy School Start Study, a cluster-randomised controlled trial. *PloS One, 10*, e0116876. doi: 10.1371/journal.pone.0116876

Pless, M., Carlsson, M., Sundelin, C., & Persson, K. (2001). Pre-school children with developmental co-ordination disorder: Self-perceived competence and group motor skill intervention. *Acta Paediatrica, 90*, 532-538. doi: 10.1111/j.1651-227.2001.tb00794.x

Poulsen, A. A., Ziviani, J. M., & Cuskelly, M. (2008). Leisure time physical activity energy expenditure in boys with developmental coordination disorder: The role of peer relations self-concept perceptions. *OTJR: Occupation, Participation and Health, 28*, 30-39. doi: 10.3928/15394492-20080101-05

Preacher, K. J., Wichman, A. L., MacCallum, R. C., & Briggs, N. E. (2008). *Latent Growth Curve Modeling*. Thousand Oaks, CA: SAGA Publications, Inc.

Raudsepp, L., Neissaar, I., & Kull, M. (2013). A longitudinal assessment of the links between physical activity and physical self-worth in adolescent females. *European Journal of Sport Science, 13*, 716-722. doi: 10.1080/17461391.2013.775349

Robins, R. W., & Trzesniewski, K. H. (2005). Self-esteem development across the lifespan. *Current Directions in Psychological Science, 14*, 158-162. doi: 10.1111/j.0963-7214.2005.00353.x

Rosenbaum, P. (2010). The randomized controlled trial: An excellent design, but can it address the big questions in neurodisability? *Developmental Medicine & Child Neurology, 52*, 111. doi: 10.1111/j.1469-8749.2009.03557.x

Skinner, R. A., & Piek, J. P. (2001). Psychosocial implications of poor motor coordination in children and adolescents. *Human Movement Science, 20*, 73-94. doi: 10.1016/s0167-9457(01)00029-x

Slawson, N. (2015, September). Miles ahead: School that fired starting gun on running revolution. The Gardian. Retrieved from http://www.thegardian.uk

Smits-Engelsman, B. C., Blank, R., Van der Kaay, A. C., Mosterd-Van der Meijs, R., Vlugt-Van den Brand, E., Polatajko, H. J., & Wilson, P. H. (2013). Efficacy of interventions to improve motor performance in children with developmental coordination disorder: A combined systematic review and meta-analysis. *Developmental Medicine & Child Neurology, 55*, 229-237. doi: 10.1111/dmcn.12008

Sonstroem, R. J., Harlow, L. L., & Josephs, L. (1994). Exercise and self-esteem: Validity of model expansion and exercise associations. *Journal of Sport and Exercise Psychology, 16*, 29-42.

Stodden, D. F., Goodway, J. D., Langendorfer, S. J., Roberton, M. A., Rudisill, M. E., Garcia, C., & Garcia, L. E. (2008). A developmental perspective on the role of the motor skill competence in physical activity: An emergent relationship. *Quest, 60*, 290-306. doi: 10.1080/00336297.2008.10483582

Sussman, M. D. (2010). 'The randomized controlled trial: An excellent design, but can it address the big questions in neurodisability?'. *Developmental Medicine & Child Neurology, 52*, 1066-1067. doi: 10.1111/j.1469-8749.2010.03708.x

Wigfield, A., Battle, A., Keller, L. B., & Eccles, J. S. (2002). Sex differences in motivation, self-concept, career aspiration and career choice: Implications for cognitive development. In A. McGillicuddy-De Lise & R. De Lisi (Eds.), *Biology, sociology, and behavior: The development of sex differences in cognition.* (Vol. 21, pp. 93-127). Greenwich, CT: Ablex Publishing.

Zwicker, J. G., Rehal, H., Sodhi, S., Karkling, M., Paul, A., Hilliard, M., Jarus, T. (2014). Effectiveness of a summer camp intervention for children with developmental coordination disorder. *Physical & Occupational Therapy in Pediatrics, 35,* 163-177. doi: 10.3109/01942638.2014.957431

Samenvatting

Summary in Dutch

In **deel I** van dit proefschrift hebben we de ontwikkeling van, en samenhang tussen, het zelfbeeld en de fysieke activiteit bij normaal ontwikkelende kinderen van groep 2 tot en met groep 6 onderzocht. In **deel II** van dit proefschrift is onderzocht of het stimuleren van het zelfbeeld tijdens een motorische interventie een positief effect heeft op het motorisch functioneren, het zelfbeeld en de fysieke activiteit bij kinderen met motorische problemen. Tevens is onderzocht wat de invloed is van het (sportief) zelfbeeld op de fysieke activiteit bij kinderen met motorische problemen.

Deel I

Veel kinderen in westerse landen zijn onvoldoende fysiek actief terwijl fysieke activiteit preventief is voor het krijgen van overgewicht en hart- en vaatziekten. Het beeld dat iemand heeft over zijn eigen sportieve vaardigheden (sportief zelfbeeld) is van invloed op de (intrinsieke) motivatie voor deelname aan fysieke activiteit. Ook is het sportief zelfbeeld van invloed op hoe tevreden iemand met zichzelf is (globaal zelfbeeld). Er is echter nog weinig bekend over de samenhang tussen globaal zelfbeeld, sportief zelfbeeld en fysieke activiteit bij kinderen. Inzicht in deze samenhang kan belangrijke informatie opleveren voor het ontwikkelen van interventieprogramma's om de fysieke activiteit en het globaal zelfbeeld te vergroten.

In **hoofdstuk 2** hebben we de ontwikkeling van, en samenhang tussen, globaal zelfbeeld, sportief zelfbeeld en fysieke activiteit bij kinderen van groep 2 tot en met groep 6 onderzocht. Tevens is onderzocht of deze ontwikkeling, en samenhang, anders is voor jongens en meisjes. Er deden twee groepen (cohorten) van kinderen mee aan het onderzoek. Kinderen in cohort I werden gevolgd van groep 2 tot en met groep 4 waarbij ze ieder jaar getest werden. Kinderen in cohort II werden gevolgd van groep 4 tot en met groep 6 waarbij ze eveneens ieder jaar getest werden. Globaal zelfbeeld en sportief zelfbeeld werden onderzocht met de Competentiebelevingsschaal voor Kinderen (CBSK) ($n = 292$; 148 jongens) en fysieke activiteit werd onderzocht met een activiteitendagboek dat voor een periode van 7 dagen werd ingevuld door de ouders ($n = 184$; 88 jongens). Globaal zelfbeeld, sportief zelfbeeld en fysieke activiteit bleven, gemiddelde genomen, stabiel tussen groep 2 en groep 6. Globaal zelfbeeld was hetzelfde voor jongens en meisjes, terwijl jongens een positiever sportief zelfbeeld hadden en fysiek actiever waren dan meisjes. Verandering in globaal zelfbeeld hing samen met de verandering in sportief zelfbeeld en de verandering in fysieke activiteit bij meisjes, maar niet bij jongens.

Kinderen participeren echter ook in activiteiten die een beroep doen op de fijne motoriek (zoals schrijven en knutselen), balvaardigheden (zoals basketbal en trefbal) en grove motoriek (zoals hinkelen en klimmen). Onderscheid maken tussen het zelfbeeld over de fijne motoriek, de balvaardigheid en de grove motoriek zorgt voor een specifiek inzicht in het motorisch zelfbeeld. Daarnaast is het belang dat iemand hecht aan de activiteit (zelfwaardering) van invloed op deelname aan deze activiteit.

In **hoofdstuk 3** hebben we daarom specifiek gekeken naar het motorisch zelfbeeld, in combinatie met de motorische zelfwaardering, door onderscheid te maken in zelfbeeld en zelfwaardering over handvaardigheid, balvaardigheid en grove motoriek. In hoofdstuk 3 zijn dezelfde twee cohorten van kinderen gebruikt als in hoofdstuk 2. Het doel van het onderzoek was het onderzoeken van de ontwikkeling van, en samenhang tussen, het zelfbeeld en de zelfwaardering over handvaardigheid, balvaardigheid en grove motoriek bij kinderen van groep 2 tot en met groep 6. Ook nu hebben we onderzocht of de ontwikkeling van, en samenhang tussen, het zelfbeeld en zelfwaardering anders is voor jongens en meisjes. Daarnaast hebben we onderzocht of deze ontwikkeling en samenhang anders is voor kinderen met een motorische achterstand en normaal ontwikkelende kinderen.

Kinderen werden gecategoriseerd als het hebben van een motorische achterstand wanneer ze op minimaal twee van de drie meetmomenten onvoldoende scoorden op een normatieve motorische test (Movement Assessment Battery for Children-2). Het zelfbeeld en de zelfwaardering werden gemeten met de Hoe ik vind dat ik het doe-vragenlijst. Het zelfbeeld over de handvaardigheid en de grove motoriek werden, gemiddeld genomen, minder positief tussen groep 2 en groep 6, terwijl het zelfbeeld over de balvaardigheid stabiel bleef. Meisjes hadden een positiever zelfbeeld over hun handvaardigheid dan jongens, terwijl jongens een positiever zelfbeeld hadden over hun balvaardigheid dan meisjes. Het zelfbeeld over de grove motoriek was hetzelfde voor jongens en meisjes.

Zelfwaardering over de handvaardigheid, balvaardigheid en grove motoriek bleven, gemiddeld genomen, gelijk tussen groep 2 en groep 6. Jongens hadden een hogere zelfwaardering over de balvaardigheid dan meisjes. Zelfwaardering over de handvaardigheid en grove motoriek was hetzelfde voor jongens en meisjes. We vonden geen verschillen in zelfbeeld en zelfwaardering tussen kinderen met een motorische achterstand en normaal ontwikkelende kinderen. Deze uitspraak wordt echter met enige voorzichtigheid gedaan vanwege het kleine aantal kinderen met een motorische achterstand in onze onderzoekspopulatie. De verandering in zelfbeeld hing niet samen met de verandering in zelfwaardering. Tevens was de samenhang niet significant verschillend tussen jongens en meisjes, en tussen kinderen met een motorische achterstand en normaal ontwikkelende kinderen.

Deel II

Sommige kinderen ervaren motorische problemen waardoor zij belemmerd worden in hun (fysieke) activiteiten in het dagelijks leven (zoals buitenspelen en deelname aan de gymles). Deze kinderen kunnen de diagnose developmental coordination disorder (DCD) krijgen. Een kind krijgt de diagnose DCD wanneer (a) het een motorische achterstand heeft ten opzichte van zijn leeftijdsgenoten, terwijl het kind wel de mogelijkheid heeft gehad om zijn motorische vaardigheden te ontwikkelen, (b) uit de hulpvraag blijkt dat de motorische achterstand de schoolse prestaties of de algemene dagelijkse activiteiten voortdurend en in belangrijke mate beïnvloedt, (c) de symptomen zich tijdens de vroege ontwikkeling manifesteren, en (d) de aandoening niet het gevolg is van een medische conditie of ernstige intelligentieachterstand. Wanneer bovenstaande criteria beschreven zijn, maar een of meerdere criteria zijn niet geëvalueerd, wordt gesproken van *mogelijke* DCD (mDCD). Kinderen met (m)DCD hebben een lager sportief zelfbeeld en zijn minder fysiek actief in vergelijking met normaal ontwikkelende kinderen. Kinderen met (m)DCD worden regelmatig gezien door de kinderfysio-, kinderergo- en/of kinderoefentherapeut om problemen in de motoriek te verminderen om zo participatie in het dagelijks leven te verbeteren (zoals participatie in fysieke activiteit). Het is echter niet bekend of het stimuleren van het sportief zelfbeeld tijdens een motorische interventie een positief effect heeft op het motorische functioneren, het zelfbeeld en de fysieke activiteit bij kinderen met (m)DCD.

In **hoofdstuk 4** hebben we daarom onderzocht wat het effect is van een geïntegreerde gedrags- en motorische interventie op het motorisch functioneren, het zelfbeeld en de fysieke activiteit bij kinderen met mDCD in de leeftijd van 7 tot en met 12 jaar ten opzichte van een reguliere behandeling. Twintig kinderen met mDCD kregen de geïntegreerde gedrags- en motorische interventie en elf kinderen met mDCD kregen de reguliere behandeling. De gedragscomponent was met name gericht op het geven van (met name) positieve, specifieke feedback op de vooruitgang van het kind tijdens de behandeling om zo het sportief zelfbeeld te verhogen. We vonden echter geen verschillen op de verschillende uitkomstmaten tussen de twee groepen. Wel gingen beide groepen kinderen vooruit in motorisch functioneren, sportief zelfbeeld, globaal zelfbeeld en ervoeren zij minder motorische problemen na 12 behandelingen. Deze vooruitgang bleef ook aanwezig nadat de kinderen 3 maanden geen therapie kregen (follow-up). De kinderen met mDCD gingen echter niet vooruit in hun fysieke activiteit. We vonden grote verschillen in motorisch functioneren, sportief zelfbeeld en de vooruitgang in motorisch functioneren tussen de kinderen met mDCD.

In **hoofdstuk 5** zijn we dieper ingegaan op de verschillen in sportief zelfbeeld en fysieke activiteit *tussen* en *binnen* een groep van kinderen met gediagnosticeerde DCD ($n = 31$) en normaal ontwikkelende kinderen ($n = 38$) in de leeftijd van 7 tot en met 12 jaar. Kinderen met DCD participeerden minder vaak in ongeorganiseerde fysieke activiteit dan normaal ontwikkelende kinderen. Er waren echter geen verschillen in georganiseerde fysieke activiteit tussen de kinderen met DCD en de normaal ontwikkelende kinderen. Kinderen met DCD hadden vaker een laag sportief zelfbeeld dan normaal ontwikkelende kinderen, maar meer dan de helft (64,5%) van de kinderen met DCD had een normaal tot hoog sportief zelfbeeld. Vervolgens hebben we de totale populatie kinderen onderverdeeld in vier groepen: (a) kinderen met DCD / laag sportief zelfbeeld, (b) kinderen met DCD / normaal tot hoog sportief zelfbeeld, (c) normaal ontwikkelende kinderen / laag sportief zelfbeeld, en (d) normaal ontwikkelende kinderen / normaal tot hoog sportief zelfbeeld. Beide groepen kinderen met DCD participeerden significant minder in ongeorganiseerde fysieke activiteit dan normaal ontwikkelende kinderen / normaal tot hoog sportief zelfbeeld, maar er waren geen verschillen met de groep normaal ontwikkelende kinderen / laag sportief zelfbeeld. Het belangrijkste resultaat van deze studie is echter dat er grote individuele verschillen zijn in sportief zelfbeeld binnen de groep kinderen met DCD.

In **hoofdstuk 6** bediscussiëren we de resultaten en de uitdagingen die we ondervonden hebben. Tevens worden richtingen voor toekomstig onderzoek bediscussieerd en klinische implicaties gegeven naar aanleiding van onze bevindingen.

Dankwoord

We zijn aangekomen bij de laatste paar pagina's van mijn proefschrift, het dankwoord. Een niet onbelangrijk onderdeel. Het dankwoord is namelijk het meest, en in veel gevallen enige, gelezen onderdeel van een proefschrift. Ik ga m'n best doen ;)

Tijdens mijn promotietraject heb ik het geluk gehad om veel bijzondere, interessante, aardige en motiverende mensen tegen te komen die ervoor hebben gezorgd dat mijn promotietraject (over het algemeen) een feest is geweest. Allereerst zijn dat uiteraard mijn promotoren en copromotor.

Prof. dr. Jongmans, best Marian, jij was mijn eerste promotor. Ik ben je erg dankbaar voor de begeleiding de afgelopen jaren. Jouw inhoudelijk scherpe feedback zette mij iedere keer weer aan het denken. Ik heb onze sociaal-wetenschappelijke discussies altijd zeer gewaardeerd. Je hebt een grote bijdrage geleverd aan de inhoud van dit proefschrift, maar ook aan de (beginnend) onderzoeker die ik nu ben. En… dankzij jou heb ik inmiddels ook een baan als docent aan de Universiteit Utrecht! Mijn dank is groot.

Prof. dr. Helders, beste Paul, ik ben je eeuwig dankbaar dat je mij deze kans hebt gegeven. Ik had geen publicaties op mijn naam, was geen uitmuntende student en had geen geld om onderzoek te doen. Toch kreeg ik na een aantal gesprekken een 0-uren aanstelling op het Kinderbewegingscentrum van het Wilhelmina Kinderziekenhuis, de start van mijn promotietraject. Nu je dit leest ben je misschien zelf ook een beetje verbaasd waarom je dit hebt gedaan. Je passie voor het vak, je visie en je enthousiasme heb ik altijd als zeer stimulerend ervaren.

Dr. van der Net, beste Janjaap, dank voor je prettige manier van begeleiden. Je hebt vanaf het begin perfect aangevoeld met wat voor een "type" je te maken had. Je hebt je begeleidingsstijl daar perfect op aangepast. Erg knap vind ik dat. Al hadden we weinig vaste tijden waarop wij elkaar spraken, altijd stond je voor mij klaar wanneer dit nodig was. Je stuurde me dan weer de goede richting op of liet mij nadenken over de keuzes die ik wilde maken. Daarnaast zijn je brede interesse en grote algemene kennis iets wat ik zeer in je waardeer.

Naast het directe begeleidingsteam zijn er uiteraard nog verschillende andere personen geweest die een grote bijdrage hebben geleverd aan het tot stand komen van dit proefschrift.

Dr. Jak, beste Suzanne, wat ben ik blij dat je mij hebt geholpen bij het uitleggen en controleren van de vele statistische analyses die wij hebben uitgevoerd voor de longitudinale studie. Ik weet niet hoe ik dit proefschrift zonder jouw inbreng af had moeten krijgen. Jouw relaxte houding, duidelijke uitleg en snelle reacties (zelfs vanuit Singapore) hebben mij erg geholpen. Ik hoop dat we de komende jaren nog veel kunnen samenwerken.

Prof. dr. Hoijtink, beste Herbert, heel erg bedankt voor al je hulp bij het uitleggen van de, voor mij, ingewikkelde statistische analyses. Iedere afspraak nam je uitgebreid de tijd om mij, als niet statisticus, de fijne kneepjes over *latent growth curves* te leren.

Dr. Voerman, beste Lia, wat ben ik blij dat ik jou ben tegen gekomen tijdens dit promotietraject. Wat fijn dat je mij hebt willen helpen bij het vormen van de interventiestudie en het opleiden van de kinderoefentherapeuten uit de interventiegroep. Nadat jij een pilot kwam uitvoeren bij ons op de praktijk, en inzicht gaf in de kracht van feedback op het gedrag van het kind, stond ik versteld van jouw deskundigheid.

Dr. Reinders-Messelink, beste Heleen, toeval bestaat niet! Wat een geluk dat ik jou ben tegengekomen bij een van de DCD-netwerkbijeenkomsten. Je wilde graag een artikel schrijven over zelfpercepties bij kinderen met DCD met bestaande data "uit het Noorden". Of ik geïnteresseerd was hierbij te helpen. Dit heeft geresulteerd in het schrijven van het vijfde hoofdstuk, en mijn eerste wetenschappelijke publicatie, van dit proefschrift. De vrijheid die je mij gaf om mee te denken, de goede feedback en je enthousiasme hebben mij erg geholpen bij de ontwikkeling tot (beginnend) onderzoeker.

Ook dank ik de andere medeauteurs, dr. Marina Schoemaker, dr. Ilse Stuive, drs. Hester Herweijer, Lian Holty en drs. Chantal Oudenampsen voor hun hulp en scherpe feedback bij het schrijven van het artikel over kinderen met DCD.

Een goede omgeving is het halve werk. Mijn collega's van het Kinderbewegingscentrum in het Wilhelmina Kinderziekenhuis kan ik daarom niet voldoende bedanken voor de gezelligheid en stimulerende werkomgeving.

Allereerst de dames van het secretariaat, Sonja Raaff, Carla van Rooijen-van der Linden en Annemiek Apeldoorn-Nelissen. Dank voor jullie hulp. Nooit waren jullie te beroerd om mij voor de 100ste keer te vertellen waar alles lag. Maar ook jullie interesse, gezelligheid en luisterend oor heb ik altijd zeer gewaardeerd. De collega's van de medische fysiologie dr. Tim Takken, dr. Erik Hulzebos en dr. Marco van Brussel, mede-promovendi, en inmiddels gepromoveerden, dr. Wim Groen, dr. Maarten Werkman, dr. Bart Bongers, dr. Janke de Groot, dr. Esther Habers, dr. Jacqueline Nuysink, dr. Renske Schappin, dank voor de interessante discussies. Mijn dank gaat ook uit naar de collega's kinderfysiotherapie en kinderergotherapie, dr. Ron van Empelen, dr. Marja Schoenmakers, drs. Rian Eijsermans, drs. Lianne Verhage-Schregardus, drs. Patrick van der Torre, drs. Maaike Bolland-Sprong, drs. Bart Bartels, drs. Rogier de Knikker, drs. Marcella Burghard, Lara van Bon, Marcel Verkaart, Marleen Schuuring en Anne de Kievit.

In het bijzonder wil ik dr. Erik Hulzebos, drs. Bart Bartels en drs. Patrick van der Torre bedanken voor hun vriendschap tijdens dit promotietraject. Zowel "promotiezaken" als "dingen waar het echt om gaat in het leven" hebben we goed weten te (over-)analyseren in de kroeg. Geluk is…

Slechts een paar 100 meter naast het Wilhelmina Kinderziekenhuis staat de Hogeschool Utrecht, waar menigeen mijn vorderingen als promovendus in de gaten hield. Allereerst wil ik de opleidingsmanager van de opleiding oefentherapie Cesar, drs. Els Mulder, hartelijk bedanken. Bedankt voor je interesse tijdens dit promotietraject. Ik waardeer het zeer dat je mij zoveel ruimte hebt gegeven de afgelopen jaren.

Daarnaast wil ik graag mijn collega's van de opleiding oefentherapie Cesar bedanken voor hun getoonde interesse. In het bijzonder wil ik noemen mijn kamergenoten drs. Meta Wildenbeest en drs. Margriet van Dijk. Rond februari 2014 werden de eerste weddenschappen, met als inzet een etentje, afgesloten op het afronden van mijn promotie. Uiteraard was ik de enige die erin geloofde dat het zou lukken om in september 2015 alle spullen bij de leescommissie in te leveren. Blijkbaar heb ik niet altijd gelijk… het etentje was wel erg gezellig. Bedankt voor al die jaren gezelligheid op kamer 0.077!

Ook wil ik graag mijn HU-collega Nienke Smorenburg bedanken voor haar steun de afgelopen jaren op de HU. Wat heb ik vaak op je mogen "leunen".

Christel Kodden, zoals beloofd, maar ook zeer verdiend, een plek in mijn dankwoord. De flauwe grappen, leuke gesprekken en relativerende opmerkingen heb ik zeer gewaardeerd de afgelopen jaren. Daarnaast wil ik je ook erg bedanken dat je af en toe wat wilde schuiven in het rooster als ik (weer) zo slim was geweest om een dubbele afspraak te maken. Alles voor de wetenschap! Ik hoop dat ik in de toekomst nog vaak mag komen "buurten".

Daarnaast zijn er al die mensen die direct hebben bijgedragen aan het onderzoek in de vorm van deelnemen als proefpersoon, onderzoeksassistent en/of deelnemend kinderoefentherapeut.

Allereerst wil ik alle ouders en kinderen die hebben deelgenomen aan de verschillende studies hartelijk bedanken. Zonder jullie inzet was dit proefschrift er nooit gekomen. Grote dank gaat ook uit naar de directies van de basisscholen waar we 3 jaar lang kinderen hebben getest: OBS Van Dijckschool (Bilthoven), Julianaschool (Bilthoven), Montessorischool Bilthoven (Bilthoven), P.C. Dalton basisschool De Rietakker (De Bilt), OBS Op Dreef (Zeist), basisschool De Nijepoort (Groenekan), P.C. basisschool De Ridderhof (Utrecht), Basisschool Hof ter Weijde (Utrecht), Basisschool Joannes XXIII (Utrecht), OBS Waterrijk (Utrecht), Paulusschool (Utrecht), Montessorischool Arcade (Utrecht), Basisschool De Notenboom (Utrecht). Ook gaat mijn dank uit naar alle leerkrachten die, het zijn er teveel om op te noemen, het goed vonden dat we ieder jaar weer een groot aantal kinderen uit de klas kwamen halen om te testen.

Dank ook aan de kinderoefentherapeuten die bereid waren om deel te nemen aan de interventiestudie. Ook dank ik de niet-praktiserende eigenaren Rens van Wijngaarden (Kind en Motoriek), Famke de Wilde (Lage Land Oefentherapie), Patty Bakx en Marianne Boot voor het geven van toestemming om als praktijk deel te nemen aan de interventiestudie.

Dank ook aan de studenten / onderzoeksassistenten van de opleidingen Oefentherapie Cesar en Fysiotherapie. Jullie hebben het geweldig gedaan!

Ook wil ik graag de inspirerende mensen uit mijn verschillende "groepjes" bedanken. Allereerst mijn mede-bestuursgenoten van het Platform Kinderoefentherapie, voorzitters Marianne Boot en Rens van Wijngaarden en bestuursleden Detti Steeman, Janneke Jonker, Monique Sassen en drs. Mignon Biesta. Ik wil jullie hartelijk bedanken voor al het werk dat jullie verzetten voor "ons" vak.

Uit de paramedische werkgroep van het DCD Netwerk zijn dit Annelies de Hoop, drs. Jolien van Houten en drs. Ruud Wong-Chung en uit SchrijvenNL zijn dit prof. dr. Ria Nijhuis-van der Sanden, dr. Margo van Hartingsveldt, drs. Ivonne Duijser, Ingrid van Bommel, dr. Anneloes Overvelde, Marie-Jose de Ridder, Mirjam Damen, Marlies Schaerlaeckens en (opnieuw) Annelies de Hoop. Ik heb jullie interesse voor mijn onderzoek altijd erg gewaardeerd.

Taylor Krohn, wat ik heb ik veel geleerd in jouw 6 weken durende cursus! Ik ben je erg dankbaar voor je hulp tijdens de cursus, maar ook voor je hulp daarna. Ik hoop dat ik nog vaak van je expertise gebruik mag maken.

Dr. Renate Siebes, heel erg bedankt voor het opmaken van het proefschrift en de uitnodigingen. Het is prachtig geworden! Ik hoop niet dat alle promovendi je zo vaak mailen met kleine aanpassingen…

Dank gaat ook uit naar de promotiecommissie bestaande uit prof. dr. H.J.A Hoijtink, prof. dr. C. Veenhof, prof. dr. K. de Martelaer, prof. dr. B. Steenbergen en prof. dr. A.L. van Baar voor het lezen en beoordelen van dit proefschrift.

Al was het soms wat lastig, ik heb toch erg mijn best gedaan om mijn sociale leven enigszins te onderhouden. Ik zou graag beloven dat het nu rustiger wordt, maar jullie kennen mij inmiddels ook wel…

Jaap Siemens en drs. Rob Bloemen, wat fijn dat jullie mijn paranimfen willen zijn op deze, voor mij, belangrijke dag. Jaap, wij kennen elkaar al sinds de peuterspeelzaal, samen zandtaartjes maken. Alle belangrijke dingen in ons leven hebben we gedeeld. De eerste vakanties zonder ouders, het studentenleven, het krijgen van een vaste relatie, samenwonen, een huis kopen en kinderen krijgen. Ik hoop dat onze vriendschap blijft voortduren totdat we samen in een bejaardenhuis zitten. Drs. Rob Bloemen, onze studententijd, en jaren daarna, hebben we intensief met elkaar meegemaakt. In Utrecht hebben we ons onsterfelijk gemaakt met onze zelfverdedigingscursus en *de* Fight Club! Je bent een vriend waar ik altijd op kan rekenen en die altijd eerlijk tegen me is, ook wanneer ik het liever niet wil horen. Bedankt voor alle jaren vriendschap en ik hoop dat er nog vele jaren bij mogen komen.

Rens van Wijngaarden, ik wil je graag heel erg bedanken. Niet eens speciaal voor de afgelopen jaren, maar eigenlijk voor alle jaren dat ik je inmiddels ken (volgens mij alweer 15 jaar). Mijn stage bij jou heeft ervoor gezorgd dat ik kinderoefentherapeut wilde worden. De afgelopen jaren heb je vele deuren voor mij geopend. Daarnaast heb je mij geleerd om je door niets of niemand te laten tegenhouden als je ergens voor wilt gaan. Bedankt voor alle jaren vriendschap, plezier en discussies over de praktijk.

Dr. Paul Mandigers, beste Paul, bedankt voor je interesse de afgelopen jaren. Onze vriendschap en etentjes waardeer ik zeer. Ook was jouw promotie de eerste die ik heb meegemaakt, een hele belevenis. Waarschijnlijk heb jij er bewust of onbewust toch aan bijgedragen dat ik ook gestart ben met dit promotietraject. Nu eindelijk tijd voor dat flesje Chateau Petrus?

Dank ook aan alle vrienden en familie in binnen- en buitenland die met regelmaat interesse toonden in mijn promotietraject. De etentjes, verjaardagen (tegenwoordig ook verjaardagen van de kinderen), vrienden-weekendjes en dagjes weg waarop we elkaar spreken zijn mij zeer dierbaar, net als jullie.

Lieve ouders, jullie hebben een belangrijke bijdrage geleverd aan het ontwikkelen van mijn (soms iets te) positieve zelfbeeld. Dit heeft me erg geholpen bij het kunnen uitvoeren van alles wat ik wil. Dank ook voor jullie hulp sinds Hugo en Fien er zijn. Het is heel fijn om zulke lieve (groot)ouders te hebben.

En dan, *last but not least*, de belangrijkste persoon in mijn leven. Lieve Rianne, wat een geluk heb ik dat jij al zoveel jaren mijn vriendin bent. Sinds we elkaar kennen is het leven één groot feest. De hoeveelheid liefde en vrijheid die jij mij geeft zijn onbeschrijfelijk. Inmiddels zijn we met z'n vieren en is ons feest echt compleet. Dank dat je er altijd voor mij bent. Kus.

About the author

Curriculum vitae

Johannes Noordstar werd geboren op 8 augustus 1981 te Wageningen. Na het behalen van zijn atheneum, en een tussenjaar waarin hij in de weekenden een opleiding tot fitnessleraar volgde, startte hij in 2000 aan de opleiding Oefentherapie Cesar aan de Hogeschool Utrecht (HU). In 2003 behaalde hij zijn diploma waarna hij direct startte met de studie Pedagogische Wetenschappen aan de Universiteit Utrecht (UU). Gelijktijdig startte hij als (kinder-)oefentherapeut op een school voor Speciaal Basisonderwijs (SBO) in Utrecht. Na het (versneld) behalen van zijn Bachelor of Science (BSc)-titel in 2005 begon hij een jaar later aan de master Klinische Gezondheidswetenschappen (afstudeerrichting Fysiotherapiewetenschappen) aan de UU. Tijdens het laatste jaar van deze opleiding heeft hij stage gelopen bij het kenniscentrum van revalidatiecentrum "de Hoogstraat" in Utrecht onder begeleiding van dr. D.W. Smits en dr. J.W. Gorter. Tijdens deze periode begon hij ook met lesgeven aan de post-HBO opleiding kinderoefentherapie aan de HU. In 2008 behaalde hij zijn masterdiploma aan de UU waarna hij zijn carrière op de HU verder uitbreidde als hogeschooldocent bij de opleidingen Oefentherapie Cesar en Fysiotherapie. In 2010 werd in samenwerking met prof. dr. P.J.M. Helders, prof. dr. M.J. Jongmans en dr. J. van der Net een promotieonderzoek opgestart in het Wilhelmina Kinderziekenhuis (WKZ), Universitair Medisch Centrum (UMC) Utrecht en de UU. Het wetenschappelijk onderzoek dat tijdens deze periode is verricht, is beschreven in dit proefschrift. Sinds 2015 begeleidt Johannes tevens masterscripties bij de opleiding Pedagogische Wetenschappen (UU). Naast zijn werkzaamheden als docent is hij werkzaam als kwaliteitscoördinator bij Kind en Motoriek, een groepspraktijk voor kinderoefentherapie.

Publications

Peer reviewed publications (ENGLISH)

Noordstar, J. J., Stuive, I., Herweijer, H., Holty, L., Oudenampsen, C., Schoemaker, M. M., & Reinders-Messelink, H. A. (2014). Perceived athletic competence and physical activity in children with developmental coordination disorder who are clinically referred, and control children. *Research in Developmental Disabilities*, *35*, 3591-3597. doi: 10.1016/j.ridd.2014.09.005

Noordstar, J. J., Van der Net, J., Jak, S., Helders, P. J. M., & Jongmans, M. J. (2016). Global self-esteem, perceived athletic competence, and physical activity in children: A longitudinal cohort study. *Psychology of Sport and Exercise*, *22*, 83-90. doi: 10.1016/j.psychsport.2015.06.009

Noordstar, J. J., Van der Net, J., Jak, S., Helders, P. J. M. & Jongmans, M. J. (2016). The change in perceived motor competence and motor task values during elementary school. *British Journal of Developmental Psychology*, *34*, 427-446. doi: 10.1111/bjdp.12142

Noordstar, J. J., Van der Net, J., Voerman, L., Helders, P. J. M., & Jongmans, M. J. (2016). *The effect of an integrated behavioral and motor intervention in children with probable developmental coordination disorder*. Manuscript submitted for publication.

Relevant national publications

Noordstar, J. (2007). Het effect van CIM-therapie op de functionele en fijn motorische vaardigheden van de arm en hand bij kinderen met een hemiplege cerebrale parese: Een systematische review. *Beweegreden*, *3*, 21-24.

Noordstar, J. J., Smits, D. W., & Gorter, J. W. (2009). Het zelfconcept bij kinderen met cerebrale parese: Een literatuurstudie. *Beweegreden*, *3*, 32-35.

Noordstar, J. (2009). Motoriek in de klas: Omgaan met niveau. *Jeugd School & Wereld*, *93*, 18-21.

Noordstar, J., & Biesta, M. (2010). Heeft kinderoefentherapie invloed op de motorische vaardigheden bij kinderen met een motorische hulpvraag? *Beweegreden*, *6*, 10-14.

Steeman, D., **Noordstar, J.**, & Biesta, M. (2012). Kinderoefentherapie: Kwaliteit van bewegen. *Beweegreden*, *8*, 9-11.

Noordstar, J. (2015). Kinderen met DCD: Is dat anders dan een kind met een motorische hulpvraag? *Beweegreden*, *11*, 8-11.

Books

Noordstar, J. (2009). *Motoriek in de basisschool*. Amersfoort, the Netherlands: Thieme Meulenhoff Amersfoort.

Poelgeest, A., **Noordstar, J.**, Mares, M., Luijnenburg-Kroes, P., & Balm, M. (2010). *Gezond bewegen kun je leren*. Den Haag, the Netherlands: Boom Lemma Uitgevers.