Gross motor performance in children with psychiatric conditions

Emck, C.

2011

Gross motor performance in children with psychiatric conditions

Claudia Emck

The work presented in this thesis was performed at the research institute MOVE, Faculty of Human Movement Sciences, VU University Amsterdam.
The printing of this thesis was partly financed by the Dutch Federation of Psychomotor Therapy, Jan Luiting Fonds, 't Web movement network and Maré-didact movement equipment.

Nederlandse Vereniging voor Psychomotorische Therapie

Lay out: Ferdinand van Nispen, Citroenvlinder DTP&Vormgeving
Cover design: Trudy Bruil
After the oil painting 'De Verliefden' (1996) by Dolf Zwerver
Printed by Ponsen & Looijen

VRIJE UNIVERSITEIT

Gross motor performance in children with psychiatric conditions

ACADEMISCH PROEFSCHRIFT

ter verkrijging van de graad Doctor aan
de Vrije Universiteit Amsterdam,
op gezag van de rector magnificus
prof.dr.L.M.Bouter,
in het openbaar te verdedigen
ten overstaan van de promotiecommissie
van de faculteit der Bewegingswetenschappen
op donderdag 26 mei 2011 om 11.45 uur
in het auditorium van de universiteit,
De Boelelaan 1105

door

Claudia Emck
geboren te Utrecht

Promoters:	Prof. dr. P. J. Beek
	Prof. dr. Th. A. H. Doreleijers
Copromoters:	Dr. R. J. Bosscher
	Dr. P. C. W. van Wieringen

Beoordelingscommissie:	Prof. dr. F. Boer
	Dr. J. van de Kamp
	Prof. dr. F. Lamers-Winkelman
	Prof. dr. H. Payne
	Prof. dr. D. A. Sugden

Voor mijn ouders

Contents

Chapter 1

General introduction

Onder 'oppervlakte' van het psychisch leven van de mens versta ik de uitdrukking van zijn innerlijk wezen en de direct waarneembare aspecten van zijn persoonlijkheid,zijn psychomotoriek, zijn lichamelijke oppervlakte [...], de daden die hij verricht [...].De oppervlakte is het meest persoonlijke, het is zijn individuele karakteristiek
(Rümke, 1962)

By the 'surface' of mental life of a human being I mean the expression of his inner experience and the immediate observable aspects of his personality,his psychomotor performance, his outer body features [...], the actions he performs [...].The surface is the most personal, it is his individual characteristic
(Rümke, 1962 translation CE)

As psychology grew out of philosophy, the Platonic undervaluation of the body compared to the mind and the Cartesian body-mind dualism in Western philosophy contributed to the idea that psychology should be concerned first and foremost with mental phenomena. Consequently, movement and motor control have been neglected in general psychology, even up till now (Rosenbaum, 2005). Recently, however, psychologists have started to acknowledge the relevance of the fact that people interact with the environment through movement and that they learn about themselves and their world by moving in it. In the words of Rosenbaum (2005, p. 313): 'motor control […] lies at the heart of the science of mental life and behaviour because it joins the two' (Rosenbaum, 2005, p. 313).

Like in general psychology, the same undervaluing of movement behaviour has been noticeable in general psychiatry. Psychomotor abnormalities are predominantly viewed upon as mere epiphenomena, and even when they are deemed of clinical significance, only little information is provided on this topic in psychiatric textbooks (see for instance Kaplan and Sadock, 2004; Rutter, Taylor, and Hersov, 1994). Motor abnormalities do receive attention in psychiatry as far as they concern side-effects of pharmacotherapy. According to Gillberg and Kaplan (2003), few psychiatrists are aware of the specific motor problems that are often comorbid with psychiatric disorders. Exceptions to this general picture include motor retardation as a feature of major depressive disorders (see Sobin and Sackeim, 1997) and a primary negative symptom in schizophrenia (Röhricht and Priebe, 2006).
Interestingly, this lack of attention for movement behaviour in general psychology and general psychiatry has been much less prominent in developmental psychology and child psychiatry. It is Darwin who seems to have set the stage in this respect. After having demonstrated, in his famous "The expression of emotions in man and animals" (1872), the intrinsic relations between emotion and bodily movements, he offered a detailed description of movements and motor responses to various conditions of stimulation, based on his day-to-day notebook of his oldest child (Darwin, 1877). One of the most famous researchers in developmental psychology who went beyond the body-mind dualism was Piaget (1952). He claimed that in the sensorimotor stage of development children gain knowledge of their surroundings through physical exploration. That is, mental development is dependent on perception and movement, and cannot be understood as an isolated, internal phenomenon. Along similar lines, it has been argued that motor perfor-

mance is essential for children as they actively explore their world, thereby developing themselves and their skills in a continuous interactive process, in which each new skill opens new opportunities for a child to engage in new activities and interactions (Bernstein, 1967; Gibson, 1988; Thelen, 2000). Moreover, psychologists started to recognize that motor performance is not only important during the first years of development, but that its impact continues well into the school age period. During this period children engage in new activities, increase their action radius and broaden their horizon beyond the primary family environment. Especially gross motor skills, such as running, jumping, catching and throwing balls become important, as they are essential for participating in games and plays with peers (Wall, 2004). Unsurprisingly, children with impaired gross motor skills are now known to be at risk for a range of physical, psychosocial and psychiatric problems such as poor self-concept, lack of social support, and anxiety (Dewey, Kaplan, Crawford, and Wilson 2002; Piek, Baynam, and Barrett, 2006; Skinner and Piek 2001; Smyth and Anderson, 2000; Wrotniak, Epstein, Dorn, Jones, and Kondilis, 2006).

As stated before, in child psychiatry movement disorders have received due attention as potentially relevant clinical features. Rutter et al. (1994) pointed to several motor abnormalities that are significant in clinical interviews and observations of children, i.e. restlessness, fluttering, fidgeting, hyperactivity, walking on tiptoes, motor excitement, motor slowness, motor stereotypes, tics, mannerisms, head banging, self-biting, catatonic states, and medication-induced movement disorders, such as tremors and tardive dyskinesia. Particularly for autism spectrum disorders (ASD, including Asperger syndrome), psychomotor features have since long been a focus of clinical interest. For instance, the importance of clumsiness as a clinical feature has been a matter of debate since the first description of Asperger syndrome in 1944 (Ghaziuddin, Tsai, and Ghaziuddin, 1992; Wing, 1981). Ill-coordinated movements and odd postures are still regarded as important clinical features in ASD, although today there is general consensus that clumsiness is not a distinguishing characteristic for these disorders *per se* (Ozonoff et al., 2008). On the contrary, clumsiness may occur in a variety of other child psychiatric conditions, such as in attention deficit/hyperactivity disorder (ADHD) and in anxiety disorders (see for instance Erez, Gordon, Sever, Sadeh, and Mintz, 2004; Fliers et al., 2009), and gross motor impairments in children have been suggested to be phenotypic indicators for future schizophrenic disorders (Erlenmeyer-Kimling et al., 2000). Furthermore, in view of the growing awareness that child psychiatric disorders often co-exist and symptoms are shared across disorders, Gillberg (2010) stated that the investigation of motor abnormalities should be an integral part of the (neuropsychological) clinical examination of all young children who are presented with behavioural or emotional problems in clinical settings.

At present, neurodevelopmental perspectives rule in child psychiatry. Child psychiatric symptoms and disorders are largely explained by abnormalities in brain functioning, either globally, i.e. there are impairments in the functioning of the brain as a whole, or locally, i.e. a particular brain region is not functioning optimally. As these neurobiological impairments occur in childhood when the brain is still developing and connections between brain regions are still evolving, the outcome on a behavioural level is unsure. As stated by Dencla (2003), "the brain is an organ that is sculpted at every level by experiences, including education" (p. 387). As a consequence, neurodevelopmental perspectives on child psychiatry incorporate motor functioning as a relevant diagnostic domain. In line with these perspectives, Halperin and Healy (2010) pointed out that movement behaviour is not only relevant from a diagnostic perspective, but might also be an important aspect of future intervention strategies to impact the long-term trajectory of neurodevelopmental disorders such as ADHD. In this regard, movement- and body-oriented interventions (Röhricht, 2009), such as psychomotor therapy and dance/movement therapy are of particular interest.

Movement- and body-oriented interventions

During the mid-20th century, movement- and body-oriented therapies came to the fore. Several forms of such therapies, sometimes subsumed under the headings of psychomotor therapy or dance/movement therapy, were introduced, all sharing the basic idea that movement, physical exercise and bodily experiences might be employed as therapeutic means to alleviate psychological and psychiatric problems. These approaches stem from different traditions.

For instance, in the USA and the UK the development of movement therapy rooted in modern dance as a performing art and the first movement therapists were often dancers themselves (Röhricht and Priebe, 2006; van Wieringen, 1997). In the UK, teachers in physical education working in special schools also contributed to the development of dance movement psychotherapy. In the USA, dance movement therapy was highly influenced by Marian Chace, who started her work as a dance performer, but became increasingly interested in dance as a language to express emotions and promote well-being. She started her therapeutic work at St. Elizabeth's hospital in Washington D.C. and worked at the famous psychiatric institution Chestnut Lodge. In 1953, she published about dance/movement therapy as an adjunctive therapy in psychiatry in the Bulletin of the Menninger Clinic. She was strongly influenced by psychoanalysis, especially by Carl Jung, and she founded the first training program for dance therapists in the 1960s in New York. In the USA and the UK clinical movement observation meant to provide the point of departure for therapeutic interventions, developed from the work of the dancer Rudolf Laban (1928, 1960), who argued that well-balanced movements reflect well-balanced mental functioning. Today the Kestenberg Movement Profile (KMP), which is strongly influenced by Laban's notions, is frequently used to obtain diagnostic information for clinical populations (Cruz and Berrol, 2004; Loman and Merman, 1996; Payne, 2006b). Dance movement therapy has long been considered to be a healing art, a process that cannot be captured in protocols or be the focus of outcome research. Therefore most of the reports on its effects were based on anecdotal evidence. Nowadays, however, the American Dance Therapy Association promotes the long-needed scientific research and theories justifying the therapeutic approaches (Berrol, 2000, 2006). In line with this development, observing client's movements and changes in movement for diagnostic and intervention purposes has also become important from a research perspective (Cruz and Berrol, 2004).

In contrast to the USA and the UK, movement observation in continental Western-European psychiatry rooted in physical education, as teachers were assigned to activate psychiatric patients by means of offering games, gymnastics, dance, and sports (Probst and Bosscher, 2001). In Germany, Ernst Kiphard, a sports teacher and originator of the 'Psychomotorische Übungsbehandlung' [psychomotor practice treatment], introduced the 'Trampolin-Körperkoordinations-Test' [trampoline body coordination test] and later the 'Hamm-Marburger Körperkoordinationstest' (Hamm-Marburg body coordination test) for clinical purposes in child psychiatry (Kiphard and Schilling, 1970). From the beginning, the German psychomotor therapy was not based on psychoanalytical concepts like dance/movement therapy, but founded predominantly on pedagogical and developmental principles (Fischer, 2004; Kiphard and Huppertz, 1968)

In the Netherlands and Flanders, the first attempts to systematically investigate movement characteristics of psychiatric patients arose during the 50s and 60s (van Roozendaal, 1957). Based on phenomenological traditions, particularly on the work of Merleau-Ponty (1945) and Buytendijk (1948, 1963), van Roozendaal (1957, 1973) developed a method of systematic movement observation in clinical psychiatry, which was published in its final version in 1973. Based on clinical experience, van Roozendaal stated that patients with mental disorders showed changes in expressive movements first, while subsequently motor performance would become affected as well. In patients with severe mental illness, both expressive movements and motor performance were found to be impaired, a condition which was called a state of 'impoverished movement'. Later, Simons built on the work of van Roozendaal to develop the Louvain Observation Scales for Psychomotor Therapy, which were widely used in psychiatric practice in Belgium (Simons, van Coppenolle, Pierloot, and Wauters, 1987).
In the same period that van Roozendaal developed his method for clinical movement observation, Salomé-Finkelstein (1962) conducted a comparative study, in which patients with schizophrenia were compared with other groups of patients and healthy participants on motor performance. She was inspired by phenomenological viewpoints as well as by early psychoanalytic and neurobiological studies on schizophrenia. Moreover, she was indebted to Gordijn's theoretical perspective on physical education and movement therapy (1958, 1975). Her movement assessment procedure consisted of several movement tasks performed in a gym at the psychiatric institution, which were observed by a group of trained raters. Overall, it was concluded that, compared to other groups of patients, the motor performance of schizophrenic patients was impaired most; they lacked for instance adequate timing, rhythm, and expressiveness.

Thus, although clinical movement observation of psychiatric patients is rooted in different traditions, throughout the Western world motor performance is accepted by therapists as a clinically significant feature. Furthermore, there is an increasing awareness in the international psychiatric field that children with neurodevelopmental disorders may benefit from movement- and body-oriented treatment approaches. Such interventions concern the broad spectrum of emotional disorders (e.g., Bart et al., 2009; Larun, Nordheim, Ekeland, Hagen, and Heian, 2006), behavioural disorders (e.g., Bornman, Mitelman, and Beer, 2007; Halperin and Healy, 2010), and pervasive developmental disorders (e.g., Dawson and Watling, 2000; Lochbaum and Crews, 2006). In view of these promising interventions for children, further insight into the relationship between motor performance and psychopathology in children is essential.

The aim of this thesis

As outlined above, motor performance is often affected in children with psychiatric disorders. This holds true for both fine and gross motor performance, as well as for expressive aspects of movement. This thesis focuses on gross motor performance, especially the subdomains *locomotion*: movement behaviours that are used to transport the body from one place to another, and *object control*: movement behaviours aimed at projecting and receiving objects, especially balls (Ulrich, 2000). This restriction was made because of the impact of gross motor skills on psychological functioning, i.e. self-concept and interactions with peers – in school-age children. Therefore, the main purpose of this thesis is to further explore the relation between child psychiatric disorders and gross motor performance. This will be accomplished in two ways. First, it will be investigated to which degree and in which domains gross motor performance is (differentially) disturbed in children with different psychiatric disorders, a question that received little attention to date. Second, it will be assessed to what extent children with gross motor impairments show psychiatric symptoms. By combining these two approaches, further insight into the relations between disorders in the psychiatric domain and impairments in the movement domain can be gained.

Furthermore, to do justice to the clinical implications of gross motor impairments and associated clinical movement features, a newly developed diagnostic tool will be presented. The most important and distinguishing characteristic of this instrument concerns the diagnosis in terms of indications for specific treatment goals and related movement- and body-oriented interventions - i.e. psychomotor therapy - tailored to the needs of specific children.

The content of this thesis

Chapter 2 of this thesis presents a review of the literature on gross motor performance of children with psychiatric disorders. As indicated earlier, psychomotor characteristics are often mentioned as clinically relevant features. These features cover a broad range of phenomena and may vary from psychomotor retardation to restlessness and odd postures and impaired gross motor skills. Therefore, the second chapter of this thesis concerns the identification of shared and distinctive clinical motor features, gross motor performance, and self-perceived motor competence, of children with emotional, behavioural, and pervasive developmental disorders[1].

Chapter 3 presents an investigation of coordination problems in gross motor skills of children with emotional, behavioural, and pervasive developmental disorders using the Test of Gross Motor Development (TGMD-II; Ullrich, 2000). The test comprises two domains*, locomotion skills*, such as running and jumping, and *object control skills*, such as throwing and catching a ball. As it is known that poor gross motor skills are in general associated with poor physical fitness (Cairney, Hay, Wade, Faught, and Flouris, 2006; Cantell, Crawford, and Doyle-Baker, 2008; Schott, Alof, Hultsch, and Meermann, 2007), several aspects of physical fitness will be investigated as well.

Chapter 4 reports a study focusing on balance in relation to anxiety. This topic was chosen because (1) the development of fundamental gross motor skills in young children is strongly associated with balance control (Assaiante, 1998; Deconinck, Savelsbergh, De Clercq, and Lenoir, 2010; Geuze, 2003; Ulrich and Ulrich, 1985), and (2) balance problems also seem associated with anxiety (Balaban and Thayer, 2001; Erez et al., and Mintz, 2004). To gain further insight into the interaction between balance and anxiety in children, a group of children with elevated levels of anxiety was compared with typically developing children by using posturographic measures.
If specific psychiatric disorders in children are characterized by impairments in motor performance, the topic of the previous chapters, the reverse question arises to what extent children with gross motor impairments show (sub) clinical symptoms of specific psychiatric disorders.

---

1 In this thesis, the relation between gross motor performance and psychopathology is the focus of interest. To define psychopathology, a combination of two approaches is used. First, the clinical-descriptive approach, as offered by the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV, APA 1994), is followed. According to DSM-IV, a person suffers from a specific mental disorder if he or she qualifies for a set of inclusion criteria. An important aspect of this conceptualization is that a clinically significant syndrome must be associated with present distress or disability or with increased risk of suffering death, pain, disability, or an important loss of freedom (APA, 1994). This dichotomous approach is consistent with medical practice: a disorder is either present or absent. Second, in concurrence with an empirical-quantitative approach, rating scales are used to investigate the severity of problems and symptoms. These continuous measures are in accordance with the view that psychopathology and normality are representing both a part of a continuum. This approach is typically used in psychological practice and research. By combining the use of both paradigms, we concur with current psychiatric literature and practice and, at the same time, do justice to the dimensional nature of many behavioural and psychological syndromes (Ferdinand et al., 2004; Gillberg, 2010; Rutter et al., 2004). In this thesis, gross motor performance will thus be investigated in relation to distinct child psychiatric disorders as well as to continuously defined levels of psychiatric symptoms and psychosocial problems.

Chapter 5 focuses on this subject. A group of children with gross motor impairments according to the TGMD-II without a psychiatric history were screened on specific types of psychiatric and psychosocial problems. In view of the previously mentioned alleged impact of poor motor skills on self-perception (Piek et al., 2006; Skinner and Piek, 2001), and the link between poor self-concept and psychiatric disorders in youth (Bolongnini, Plancherel, Bettechart, and Halfon, 1996; Byrne, 2000), we also investigated self-perceived competence on six domains in this group.

Chapter 6 is concerned with the diagnosis of gross motor performance in relation to movement-oriented and body-oriented interventions in child psychiatry. Indications for these therapies in clinical practice are usually based on the type of psychiatric disorder, while psychomotor features are rarely taken into account. Given the prevalence of co-occurrence of disorders and the sharing of symptoms across disorders in child psychiatry and developmental medicine (Gillberg, 2010), children need to be assessed on a broad spectrum of symptoms and developmental problems before tailored treatment can be provided. In view of these considerations, a newly developed instrument for psychomotor diagnosis and indications for psychomotor therapy will be presented in this chapter.

In the final **Chapter 7**, the main findings of the studies in this thesis will be discussed in relation to each other and in view of recent neurodevelopmental theories. Furthermore, clinical implications for the treatment of children with neurodevelopmental problems will be discussed.

Chapter 2

Gross motor performance and self-perceived motor competence in children with emotional, behavioural, and pervasive developmental disorders: a review

This chapter has been published as:

Emck, C., Bosscher, R. J., Doreleijers, Th. and Beek, P.J. (2009).
Gross motor performance and perceived motor competence
of children with mental disorders.
Developmental Medicine & Child Neurology, 51, 501-517.

Abstract

Aims: Motor performance and self-perceived motor competence have a great impact on the psychosocial development of children in general. In this review, empirical studies of gross motor performance and self-perception of motor competence in children with emotional (depression and anxiety), behavioural, and pervasive developmental disorders are scrutinized, with the objective of identifying specific motor characteristics that may be relevant to clinical practice.

Method: A systematic search of studies published between 1997 and 2007 was performed using nine search engines.

Results: Children in all three categories (emotional, behavioural, and pervasive developmental disorders) exhibit poor gross motor performance and problematic self-perception of motor competence, with certain indications of disorder-specific characteristics. In particular, children with emotional disorders have balance problems and self-perceived motor incompetence; children with behavioural disorders show poor ball skills and tend to overestimate their motor performance; children with pervasive developmental disorders demonstrate poor gross motor performance and self-perceived motor incompetence. As a result, children with psychiatric disorders are restricted in participating in games and play, which may lead to inactive lifestyles and further disruption of their psychosocial and physical development.

Interpretation: Motor problems need more, to some extent disorder-specific, attention in clinical practice than has been provided to date.

Introduction

Children with developmental and emotional disorders often exhibit motor problems. Clinically, the motor behaviour of these children is often described as wooden, clumsy, and less fluent, with stereotypical movements and impaired gross motor skills (Bauman, Löffler, Curic, Schmidt, and von Aster, 2004; Harvey and Reid, 2005). In spite of these observations, the specific impact of poor motor skills on mental health and development often seems under-recognized in child psychiatry and is therefore deserving of more attention than is currently given (Gillberg and Kadesjö, 2003; Kristensen and Torgersen, 2007). Only for a number of disorders described in the DSM-IV (APA, 1994), such as pervasive developmental disorder (PDD) and attention-deficit–hyperactivity disorder
(ADHD), are motor problems reflected in established diagnostic criteria (APA, 1994; Rutter, Taylor, and Hersov, 1994). For instance, autism is characterized by 'stereotyped and repetitive motor mannerisms (e.g. hand or finger flapping or twisting, or complex whole-body movements) (APA, 1994). These motor problems are not limited to instrumental skills but also involve behaviours related to interpersonal communication; for example, autism is accompanied by marked impairments in nonverbal behaviour, such as postures and gestures that mediate social interaction (APA, 1994; Rutter et al., 1994).

The systematic study of the motor behaviour of children with emotional, behavioural, and pervasive developmental disorders will improve diagnostic assessment and identify specific developmental needs, from both a clinical and a developmental point of view. The study of motor characteristics in children with these disorders may also provide insight into their developmental level of functioning, the activities they are able to perform, their capabilities, and their difficulties when interacting with peers (Harvey and Reid, 2005; Cairney, Hay, Mandigo, Wade, Faught, and Flouris, 2007; Piek, Baynam, and Barrett, 2006; Rasmussen and Gillberg, 2000; Smyth and Anderson, 2000; Wrotniak, Epstein, Dorn, Jones, and Kondilis, 2006). However, most empirical studies have focused on selected aspects of motor functioning in psychiatric subgroups. What is lacking is a general assessment of the motor problems observed in children within the range of developmental and emotional disorders, aimed at determining the degree to which those problems are either general or disorder-specific. In the present review, we aim to fill this gap by identifying shared and distinguishing features of gross motor performance and self-perceived motor competence in broadly defined categories of developmental and emotional disorders that are relevant for clinical practice.

Poor gross motor performance is explained by biological, psychological, and social factors and their interactions. The concept of deficits in attention, motor control, and perception (Gillberg and Kadesjö, 2003; Kadesjö and Gillberg, 1998, 1999, 2001) has been put forward to define the widespread condition of a conglomerate of symptoms of ADHD and developmental coordination disorder (DCD), reflecting some form of neurodevelopmental dysfunction (Piek and Dyck, 2004; Visser, 2003). Atypical brain development has also been put forward as an explanation for poor gross motor performance (Crawford, Kaplan, and Dewey, 2006; Gilger and Kaplan, 2001; Kaplan, Crawford, Cantell, Kooistra, and Dewey, 2006; Kaplan, Dewey, Crawford, and Wilson, 2001; Kaplan, Wilson, Dewey, and Crawford, 1998). This is not limited to specific areas or sites but concerns the entire brain and may manifest in different ways, leading to problems with learning, attention, and motor control, as well as developmental problems and disorders. However, the concepts of atypical brain development and deficits in attention, motor control, and perception are not specific enough to provide a satisfactory account of the origin of motor and other developmental problems. Therefore Visser (2003) formulated the automatization deficit hypothesis, postulating that cerebellar dysfunction leads to impaired skill learning and automatization, and thus to poor motor performance and attention deficits. In line with this hypothesis, a disorder-specific learning theory was proposed by Erez, Gordon, Sever, Sadeh, and Mintz (2004) in which children who fail to cope with balance-threatening situations as a consequence of a deficiency in motor learning, also associated with cerebellar dysfunction, develop a generalized state of anxiety.

Given that the development of gross motor skills in school-aged children (i.e. aged 6–12y) is mediated by interaction with peers in games and play, psychosocial perspectives are accordingly essential. Gross motor performance is particularly important in the lives of schoolchildren, as participation in games and sports often requires skills such as running, jumping, and throwing balls and is known to affect psychosocial functioning when hampered (Skinner and Piek, 2001; Wrotniak et al., 2006). Similarly, the child's own perception of their level of competence, whether realistic or not, is known to have an impact on social and emotional functioning (Harter, 1978; Skinner and Piek, 2001; Ruiz Pérez, and Graupera Sanz, 2005). Poor relationships with peers, negative social feedback, negative self-perceptions, depressive symptomatology, and academic and behavioural problems are all associated with motor problems (Gillberg and Kadesjö, 2003; Piek et al., 2007) whether as cause or effect. Wall (2004) postulated that, when children with poor physical skills mature, they will have increasingly greater difficulty in participating in movement activities as a result of deprivation of skill practice while their peers engage in more complex and demanding physical activities (skill-learning gap hypothesis). In support of this model, Cairney et al. (Cairney, Hay, Faught, Mandigo, and Flouris, 2005; Cairney, Hay, Faught, Wade, Corna, and Flouris, 2005; Cairney, Hay, Faught, Corna, and Flouris, 2006) found that children with motor problems participate less in physically active play and other physical activities than their peers, partly because of low generalized self-efficacy. This activity- deficit model applies even more strongly to children with both motor and developmental and emotional problems, as their social and behavioural problems hamper participation in movement activities (Massion, 2006; Rosser Sandt and Frey, 2005)

It is, therefore, evident that motor problems in children with developmental and emotional disorders are both objective and subjective. On the one hand these children perform poorly on perceptual-motor tasks, especially tasks involving transactions of the entire body relative to the environment; on the other hand they often have a poor image and appraisal of themselves as capable actors.

In line with epidemiological psychiatric research and clinical care programmes the following three broadly defined categories of developmental and emotional disorders are distinguished in the present review: emotional disorders, behavioural disorders, and the specific developmental disorder PDD (Egger and Angold, 2006). Not only are these disorders likely to have distinct neurological and neurobiological substrates, they also typically demand different treatment strategies, tailored of course to individual characteristics and symptoms.

Children with emotional disorders are characterized primarily by symptoms of depression and anxiety. On a syndrome level, Achenbach (1991) refers to these as internalizing problems. Although in DSM-IV anxiety disorders and mood disorders are defined separately, they are here grouped because of the high level of comorbidity of these disorders and the strong heterotypic continuity of depression and anxiety (Costello, Mustillo, Erkanli, Keeler, and Angold, 2003).

In contrast, children with behavioural disorders are characterized primarily by problems with interacting with others, also described as externalizing problems (Achenbach, 1991) Hence, for this review the DSM-IV classifications ADHD, oppositional defiant disorder, and conduct disorders are grouped, a decision that is also justified by the frequent co-occurrence of these disorders in children (Costello et al., 2003; Egger and Angold, 2006). Because ADHD and DCD often go hand in hand, literature on comorbid DCD was also considered in charting the gross motor performance and perceived motor competence of children with behavioural disorders. Although DCD is a separate classification in the DSM-IV, we did not consider children with DCD only in this review, because these children suffer by definition from motor problems. Moreover, they are seldom seen by child psychiatrists but are frequently referred for physical or occupational therapy (Dewy and Wilson, 2001).

Children with PDD, also referred to as autism spectrum disorders, do not uniquely fall in either of the previous categories, as they often show a mixture of both emotional and behavioural problems, with deficits in communication and social development and restricted and repetitive behaviours as core features (APA. 1994; Lord and Rutter, 1994; Volkmar, Lord, Bailey, Schultz, and Klin, 2004). For this reason, we treat this type of disorder as a third, separate category.

In selecting these three main categories, as umbrellas under which we refer to specific psychiatric disorders according to the DSM-IV classification, the most common forms of childhood emotional, behavioural, and pervasive developmental disorders were covered (Egger and Angold, 2006). Although we believe that our classification based on primary symptoms has a basis in both clinical practice and theoretical considerations, it is clear that there will be considerable overlap in secondary symptoms. However, as many comorbid patterns preclude a clear-cut distinction between diagnostic groups regardless of the classification criteria being used (Angold, Costello, and Erkanli, 1999), such overlap seems unavoidable. Given our aim to identify the common and distinguishing features of gross motor performance in these categories, this overlap is taken for granted and is not seen as an a priori invalidation of this review. Following the Method section below, the characteristic clinical motor features, gross motor performance, and self-perceived motor competence of each of the three main categories will be addressed. The article will then be drawn to a close with a discussion of the main results and their implications for treatment.

Method

This study was initiated with a systematic literature review in selected databases using strict inclusion criteria. Specifically, a literature search was performed in the following databases: Medline, Cochrane, PsycInfo, Scirus, Web of Science, Science Direct, Eric, Sport Discus, and Picarta. Those databases were searched using DSM-IV5 and World Health Organization International Statistical Classification of Diseases and Related Health Problems, 10th Revision (ICD-10; World Health Organization, 2003) criteria related to the three subgroups of interest. More general terms such as 'children' and 'psychiatric ⁄ developmental and emotional patients' were screened in combination with the following more specific terms:'(psycho)motor functioning', '(gross) motor performance','(gross) motor coordination', '(gross) motor ability', '(gross) motor skills', '(gross) motor development', 'clumsiness', 'movement behaviour', 'perceived (motor) competence', and 'self-perceptions'. In addition, we followed up references in the papers to detect additional relevant studies that were not found in the initial literature search.

To focus on recent information, to enhance the possibility of comparable research groups, and to avoid outdated terminology that might complicate the interpretation of the results of the included studies, the search period was limited to the period 1997 to 2007. The search was restricted to schoolchildren aged 6 to 12 years because motor problems are known to be particularly detrimental to psychosocial development in this group.
Studies were included if the research group was clearly defined in terms of developmental and emotional problems or psychiatric disorders as assessed by standardized diagnostic instruments. Furthermore, measurements of gross motor performance and self-perception of motor competence had to be of verifiable psychometric quality (see Table I for an overview; Bille, Brieditis, Steen, and Ekström, 1995; Bruininks, 1978; Denckla, 1974; Denckla, 1985; Erez et al., 2004.; Harter, 1982; Harter, 1985; Hay, 1992; Henderson and Sugden, 1992; Kadesjö and Gillberg, 1998; Kakebeeke, Jongmans, Dubowitz, Schoemaker, and Henderson, 1993; Laszlo and Bairstow, 1985; McCarron, 1997; Rogé, 1984; Sandberg, Rutter, and Taylor, 1978; Schilling and Kiphard, 1974; Smyth and Anderson, 2000; Wilson, Kaplan, Crawford, Campbell, and Dewey, 2000). Both controlled studies with matched comparison groups and population studies were included.

Table I: Tests and scales of gross motor performance and self-perception of motor competence

Name of measure	Subscales	Domain
Bruininks–Oseretsky Test of Motor Proficiency (BOTMP) (Bruininks, 1978)	Gross motor: running speed, agility, balance, bilateral coordination, strength Fine motor: response speed, visual motor control, upper limb speed, dexterity	Gross and fine motor skills in children aged 4y 6mo to 14y 6mo
BOTMP Short Form (Bruininks, 1978)	Selected items of the BOTMP	General motor functioning of children aged 8–14y
Children's Self Perceptions of Adequacy in and Predilection for Physical Activity (Hay, 1992)	20-item survey	Self-perception of adequacy in performing and desire to participate in physical activities
Developmental Coordination Disorder Questionnaire (Wilson et al., 2000)	17-item survey	Parental perspective of children's functional difficulties across environmental domains as a consequence of poor motor skills
Folke Bernadotte Test (Bille et al., 1995)	11 motor items: jumping with feet together, hopping on left and right foot, alternating jumping left and right foot, walking with toes turned outward and inward, throwing and catching a ball, tying a knot, alternating movement: right hand to left chest - left hand to right chest, standing with arms outstretched while performing pronation–supination movements, diadochokinesis.	General motor functioning of children
Körper koordinationstest für Kinder [Body coordination test for children] (Schilling & Kiphard, 1974)	Control and regulation of movement (agility, physical strength), coordination under pressure of time, speed, and muscle power of limbs	Motor performance
Kinaesthetic Sensitivity Test (Lazlo et al., 1985)	Kinaesthetic acuity Kinaesthetic perception and memory	Relative sensitivity of the upper limbs to passive movements
Lincoln–Oseretsky Motor Development Scale (Rogé, 1984)	Fine manual mobility, general coordination, neuromotor coordination, wrist and finger mobility, balance, global manual mobility	Motor performance, motor impairments

Name of measure	Subscales	Domain
Movement Assessment Battery for Children (Henderson & Sugden, 1992)	Manual dexterity, ball skills, balance	Fine and gross motor impairment in children aged 4–12y
McCarron Assessment of Neuromuscular Development (McCarron, 1997)	Gross motor: finger/nose/finger, hand strength, heel to toe walking, jumping, one foot Fine motor: beads in a box, beads on a rod, nuts and bolts, finger tapping, rod on slide	Motor coordination
Neurodevelopmental Screening Test modified (Kadesjö & Gillberg, 2001)	Hopping left and right foot, standing on left and right leg, diadochokinesis left and right, walking on sides of feet, jumping back and forth across a line, alternating jumping with the left then right foot forward, finger tapping, finger imitation	Neuromotor development, gross and fine motor development
Perceived Competence Scale for Children (Harter, 1982)	Cognitive competence, social competence, physical competence, general self worth	Perceived self-competence
Playground observation (Smyth & Anderson, 2000)	Gross motor games, skill mastery, rough and tumble play, formal team games, informal team games, fine motor games, social interaction	Physical and social play behaviour
Scored Developmental Neurological Examination (Sandberg et al., 1978; Kakebeeke et al., 1993)	Motor coordination: choreiform movements, conjugate eye gaze Complex fine-motor activities: smoothness, accuracy and mirroring of upper limb alternating movements Cerebellar signs	Subtle signs and motor coordination
Self Perception Profile for Children (Harter, 1985)	Scholastic competence, social acceptance, athletic competence, physical appearance, behavioural conduct, and global self worth.	Self-perception
Balance tests (Erez et al, 2004)	Two legs standing balance, one leg standing balance, walking balance Variations: surface, foot base with, eye states, head position, after axial self spinning	Static and dynamic balance
Time-to-do 20 Motor Battery (Denckla, 1974, 1985)	Complex foot movements, complex hand movements	Pure motor output, free of problem solving

In view of issues of reliability and statistical power, in principle, only studies with at least 30 children were deemed suitable for inclusion. However, if not enough studies satisfying the methodological criteria were retrieved for either one of the two aspects of motor functioning of interest (i.e. gross motor performance and self-perceived motor competence) within a category, the inclusion criteria were relaxed, and other studies were taken into consideration. Although this inevitably implied a degree of corruption of the methodological rigour of the review, this proved to be a necessary consequence of the paucity of studies available on the topic in some domains.

Emotional disorders

Clinical motor features

The clinical features of mood and anxiety disorders include several body- and movement-related aspects.5,6 Anxiety disorders in children are associated with psychophysiological symptoms, such as shortness of breath and high muscle tension, which directly affect the child's movement behaviour. Children with anxiety disorders engage less often in physical activity, and their play behaviour is characterized by withdrawal and diminished enjoyment (APA, 1994; Kirkcaldy, Shephard, and Siefen, 2002; Klein, 1994; Sadock and Sadock, 2003). Trauma-related anxiety is associated with problematic body experiences, such as pain and feelings of discomfort, that contribute to a negative body image and problems with walking, sitting, and playing (Lamers-Winkelman, 1997; Sadock and Sadock, 2003). Depression in children is associated with somatic complaints such as abdominal pains, psychomotor agitation or retardation, fatigue, reduced ability to experience pleasure, and decreased general activity (APA, 1994). Moreover, when interacting with other people depressive children express themselves predominantly through nonverbal communication (Harington, 1994). In children younger than school age, features such as psychomotor retardation and lack of brightening in response to joyful events are related to the melancholic subtype of depression (Luby, Mrakotsky, Heffelfinger, Brown, and Spitznagel, 2004).

Gross motor performance

Three studies were found that met our criteria for gross motor performance: two clinical studies (Bauman et al, 2004; Vance, Arduca, Sanders, Karamitsios, Hall and Hetrick, 2006) and one non-clinical, population-based study (Kristensen and Torgersen, 2007). Another study (Erez et al., 2004) did not meet our sample-size criterion, but it was included in view of the relevance of its findings and the dearth of other studies on this topic. In addition, three studies were included in which the relationship between emotional problems and gross motor performance were investigated in non-clinical samples (Dewey, Kaplan, Crawford, and Wilson, 2002; Green, Baird, and Sugden, 2006; Smyth and Anderson, 2000) using markedly different selections of children and dependent measures (Table II).

Bauman et al. (2004) investigated children staying in psychiatric institutions with externalizing, internalizing, combined externalizing–internalizing, or other disorders. Using the norms of the Körper Koordinationstest für Kinder (Body Coordination Test for Children; Schilling and Kiphard, 1974), motor performance was 'impaired' and 'noticeable' in all subgroups in an unspecific manner (i.e. independent of psychiatric diagnosis). Vance et al. (2006) compared children with dysthymia, anxiety disorders, or ADHD and matched controls and found motor coordination problems in the dysthymic children, particularly in the form of increased choreiform movements, whereas the anxiety group showed increased mirror movements. However, on the basis of parent reports, the investigators found no delay in motor development in any group. Erez et al. (2004) tested children with anxiety disorders on static and dynamic balance tasks. Children with anxiety disorders made more balance mistakes and performed more slowly on the more challenging tasks than age-matched controls. Therefore, the authors concluded that children with anxiety disorders are sensitive to balance-challenging conditions and exhibit poor motor balance in daily life. Kristensen and Torgersen (2007) compared the motor performance of socially anxious children, impulsive children, and non-anxious or non-impulsive children using the total score of the Movement Assessment Battery for Children (Henderson and Sugden, 1992). Socially anxious and avoidant children performed worse on this assessment than non-anxious and non-avoidant ones. Avoidant personality traits were particularly associated with severe motor impairment.

With regard to the relationship between emotional problems and gross motor performance, Smyth and Anderson (2000) concluded from an observational playground study that children with impaired motor coordination were less involved in social play and thus at risk of becoming isolated and solitary. These findings are in line with those of Dewey et al. (2002) who found that children with motor problems scored more highly on all three

Table II: Studies on gross motor performance and self-perceived perception of motor competence in children with emotional disorders

Study	Research group and inclusion	Comparison groups	Tests and scales	Findings
Gross motor performance				
Bauman et al. (2004)	102 inpatient children, aged 5-13 y; 79 ♂, 23 ♀; 34 internalizing according to ICD-10 criteria	34 internalising, 24 externalising , 31 combined, 31 other; norm group from older study	KTK	All subgroups were below average, with no differences between subgroups
Dewey et al. (2002)	174 schoolchildren aged 8-14y; 118 ♂, 56 ♀; CBCL syndrome subscales	45 children with DCD, 51 suspected DCD, 78 normal comparison	MABC, BOTMP	Children with motor problems exhibit more internalizing problems (withdrawn, somatic complaints, anxious/depressed)
Erez et al. (2004)	20 children with anxiety disorder (ambulant) aged 7-14y; 12 ♂, 8 ♀; DSM-IV criteria & FSSC	20 matched controls	Static and dynamic balance tasks	Children with anxiety disorders have poor balance
Green et al. (2006)	47 schoolchildren referred to occupational therapy aged 5-10y; 39 ♂, 8 ♀; SDQ		MABC, DCDQ	Impaired motor performance is associated with high incidence of social and emotional problems
Kristensen & Torgersen (2007)	Population based sample of 150 children aged 11-12y; 75 ♂, 75 ♀; SASC-R, CPNI	50 socially anxious, 50 impulsive, 50 non anxious or impulsive; 31 clinical avoidance, 119 nonclinical avoidance	MABC	Avoidant personality traits are associated with poor motor performance

Study	Research group and inclusion	Comparison groups	Tests and scales	Findings
Smyth & Anderson (2000)	110 schoolchildren aged 6-10y; 76 ♂, 34 ♀	55 typically developing, 55 with DCD	MABC, playground observation	Impaired motor performance is associated with less involvement social play and social isolation
Vance et al. (2006)	25 children with anxiety disorders, 37 with dysthymia from clinical sample 6-12y; 42 ♂, 20 ♀; A-DISC, R-CMAS, CBCL, CDS; DSM-IV criteria	20 typically developing controls, 37 with ADHD	SDNE + parent reports	Increased motor coordination problems in dysthymia. Increased mirror movements in anxiety disorders. No delay in motor development
Self-perception of motor competence				
Cairney et al., 2007	590 schoolchildren aged 9-14y; 322 ♂, 268 ♀; 44 children with DCD		CSAPPA, BOPMT-short form	Motor problems are associated with less enjoyment in PE and negative self-perception of motor competence
Piek et al., 2006	165 schoolchildren aged 7-15y; 84 ♂, 80 ♀		SPPC, MAND	Poor motor performance is associated with perceived incompetence in several domains (scholastic, athletic, physical appearance, behavioural conduct)
Skinner & Piek, 2001	218 schoolchildren aged 8-10y; 80 ♂, 138 ♀; STAI	58 children with DCD aged 8-10y, 58 control children aged 8-10y, 51 with DCD aged 12-14y, 51 control children aged 12-14y	SPPC, MABC	Poor motor performance is associated with low perceived competence and high level of state and trait anxiety
Wrotniak et al., 2006	65 children from a population sample aged 8-10 years; 31 ♂, 34 ♀		CSAPPA, BOPMT	Self-perception of motor competence is positively associated with motor proficiency

Abbreviations Table II: *ADHD, Attention deficit/hyperactivity disorders; A-DISC, Anxiety Disorders Interview Schedule; BOTMP, Bruininks Oseretsky Test of Motor Proficiency; CBCL, Child Behaviour Checklist; CDS, Children's Depression Scale; CPNI, Coolidge Personality and Neuropsychological Inventory for Children; CSAPPA, Children's Self Perceptions of Adequacy in and Predilection for Physical Activity; DCD, Developmental Coordination Disorder; DCDQ = DCD Questionnaire; DSM-IV, Diagnostic and Statistical Manual of Mental Disorders; FSSC, Fear Survey Schedule for Children; ICD-10, World Health Organization International Statistical Classification of Diseases and Related Health Problems, 10th revision; KTK, Körper Koordinationstest für Kinder)body coordination test for children); MABC, Movement Assessment Battery for Children; MAND, McCarron Assessment of Neuromuscular Development; R-CMAS, Revised Child Manifest Anxiety Scale; SASC-R, Social Anxiety Scale for Children – Revised; SDNE, Scored Developmental Neurological Examination; SDQ, Strength and Difficulties Questionnaire; SPPC, Self Perception Profile for Children; STAI, State Trait Anxiety Inventory.*

internalizing subscales of the Child Behaviour Checklist (Achenbach, 1991) (i.e. withdrawn, somatic complaints, and anxious ⁄ depressed). Moreover, in a study by Green et al. (2006) parents reported a high incidence of social and emotional problems in children with impaired motor performance. Thus, regardless of the perennial issue of cause and effect, motor problems have been shown to be associated with depression and anxiety.

In the aforementioned studies, there were clear indications of poor gross motor performance in children with emotional disorders, although these indications did not appear to be very specific with regard to the type of disorder (e.g. anxiety versus mood disorders). Similarly, the indications were also not very specific with regard to the aspects of gross motor performance that were affected (e.g. locomotion versus object control), except that balance problems were more prevalent in children with anxiety disorders (Erez et al. 2004).

Self-perception of motor competence

Although depressive symptoms in children are associated with perceived incompetence in general (Harington, 1994) no study was found that met our criteria on perceived motor competence in clinical samples of children with emotional disorders. However, four studies on perceived motor competence and emotional problems in non-clinical groups were retrieved (Cairney et al., 2007; Piek et al, 2006; Skinner and Piek, 2001; Wrotniak et al., 2006).

Skinner and Piek (2001) reported on the relationship between motor performance and self-perception and anxiety in schoolchildren. Poor motor performance was associated with low self-perceived competence in several domains (scholastic, athletic, physical appearance, global self-worth) and high levels of state and trait anxiety. Similar results were reported in studies by Cairney et al. (2007) and Wrotniak et al. (2006), where motor problems were found to correlate with low levels of physical activity, less enjoyment, and negative self-perceptions of motor competence. Thus, in the motor domain, self-perceptions are negative but not necessarily unrealistic. Furthermore, Piek et al. (2006) showed that athletic competence is an important determinant of self-worth in males. Although the studies found on self-perception of motor competence in relation to psychosocial problems were quite diverse and difficult to compare, they all pointed in the same direction: gross motor impairment is closely associated with both low self-perceived competence and emotional problems.

Behavioural disorders

Clinical motor features

The DSM-IV criteria for ADHD include several items that are related to motor characteristics, including fidgeting, running about or excessive climbing (possibly linked to subjective feelings of restlessness), difficulties in playing, and acting as if 'driven by a motor' (APA, 1994). Age-inappropriate features such as hyperactivity and excessive impulsivity are hallmarks of the movement behaviour of children with ADHD. Furthermore, children with ADHD exhibit problems in lateralization and are often left-handed (Reid and Norvilitis, 2000). General coordination difficulties and soft neurological signs are frequently reported (Blondis, 1999; Denckla, 2003; Sadock and Sadock, 2003). Finally, about 50 per cent of children with ADHD have comorbid DCD (Gillberg et al., 2004; Gillberg and Kadesjö, 2003; Rasmussen and Gillberg, 2000). Fine motor skills such as writing and tying shoe-laces are typically the most problematic skills in the latter group (Piek, Pitcher, and Hay, 1999; Whitmont and Clark, 1996). Other behavioural disorders, such as oppositional defiant disorder or conduct disorder, often co-occur with ADHD like symptoms. Netelenbos (1998) argued that the psychomotor behaviour of children with conduct disorder is unremarkable, although Aendekerk and Verheij (1997) suggested that tension, restlessness, psychomotor agitation, and disturbed development of body awareness are often present. Furthermore, behavioural disorders and emotional disorders are usually intertwined, especially in young children, and it is an issue of debate whether these mixed disorders (Baker, 1998) are characterized by psychomotor agitation (Baker, 1998; Denkla, 2003; Kashani, Henrichs, Reid, and Huff, 1982; Marmorstein, 2007).

Gross motor performance

A number of studies of gross motor performance were found, mostly in relation to ADHD. Some of these studies included children with a diagnosis of ADHD (Beyer, 1999; Dewey, Cantell and Crawford, 2007; Hinshaw, Carte, Sami, Treuting, and Zupan, 2002; Miyahara, Möbs, and, Doll-Tepper, 2001; Piek et al., 1999; Pitcher, Piek and Barrett, 2002; Pitcher, Piek and Hay, 2003; Tseng, Henderson, Chow and Yao, 2004; Vance et al., 2006), whereas others focused on symptoms of ADHD in schoolchildren (Dewey et al., 2002; Kadesjö and Gillberg, 1998, 1999, 2001), or in children with learning disorders (Chaix, Albaret, Brassard, Cheuret, and Castelnau, 2007; Kaplan et al., 1998). No specific study was found involving children with oppositional defiant or conduct disorder, except for three studies that were concerned with motor performance in relation to externalizing behaviour independent of the specific disorder (Bauman et al., 2004; Green et al., 2006; Livesey, Keen, Rouse, and White, 2006) In total, 17 studies were included that addressed the relationship between gross motor performance and behavioural disorders (Table III).

Nine studies included clearly defined groups of children with ADHD and used several measures of gross motor performance. The Movement Assessment Battery for Children was used in four studies (Miyahara et al., 2001; Piek et al., 1999; Pitcher et al., 2002, 2003), three of which came from the same group of researchers who studied differences between subgroups of males. Compared with controls, males with ADHD exhibited poor motor performance (Pitcher et al., 2003; Piek et al., 1999). Piek et al. compared predominantly inattentive and combined hyperactive–inattentive males with ADHD. The combined hyperactive–inattentive subgroup experienced difficulties in gross motor skills, especially on the balance subtest. The two subgroups did not differ in ball skills, which involve a combination of fine and gross motor skills. However, in a study that included a third subgroup, hyperactive–impulsive males, differences in subgroups were found for ball skills but not for balance (Pitcher et al., 2003). The predominantly inattentive subgroup performed worse on ball skills followed by the combined hyperactive–inattentive subgroup then the hyperactive–impulsive subgroup. Moreover, the hyperactive–impulsive subgroup did not differ on ball skills from children without ADHD or motor coordination problems. In a third report, apparently based on data from the same participants, Pitcher et al. (2002) concluded that problems in force control were indicative of the comorbid condition of DCD and ADHD in males. Miyahara et al. (2001) showed a prevalence rate of 35 to 55% for comorbid DCD in children with ADHD from three sample sources

(school, support group, and hospital). All groups performed better on ball and balance skills than on manual dexterity.
The Bruininks–Oseretsky Test for Gross Motor Performance was used in three additional studies in this category (Beyer, 1999; Dewey et al., 2007; Tseng et al, 2004). In the study by Beyer (1999), 76 males with ADHD performed worse on the bilateral coordination and strength subtests, but not on balance, than males with learning disorders. Dewey et al. (2007) found that children with ADHD and DCD performed worse than children with ADHD only and typically developing children, but better than children with autism; the authors acknowledged that by using the short form of the Bruininks–Oseretsky test it was not possible to comment on specific patterns in motor performance. However, Tseng et al. (2004) conducted all subtests in a group of children with combined hyperactive–inattentive ADHD and found that that these children exhibited poorer gross motor performance than children without ADHD, especially on balance tasks. Furthermore, the activity level of the children was inversely related to their gross motor performance. Using other measures of gross motor performance, Hinshaw et al. (2002) concluded that gross motor speed was impaired in females with ADHD (combined hyperactive–inattentive or predominantly inattentive), whereas Vance et al.(2006) found increased motor coordination problems in children with combined hyperactive–inattentive ADHD compared with normally developing children.

A second group of studies refers to ADHD symptoms in schoolchildren (Dewey et al., 2002; Kadesjö and Gillberg, 1998, 1999, 2001). Dewey et al. (2001) formed and analysed the following three subgroups: children with DCD, those at risk of DCD, and a comparison group of children without motor problems. Children with or at risk of DCD displayed significantly more symptoms than the comparison group, indicating that motor problems and attentional problems are linked. This is consistent with previous findings (Kadesjö and Gillberg, 1998, 1999, 2001) indicating that symptoms of DCD and ADHD are strongly associated in schoolchildren. Moreover, in these studies the combination of ADHD and DCD was strongly correlated with school dysfunction.
Two studies were performed in schoolchildren with learning disorders. Chaix et al. (2007) studied children with dyslexia, whereas Kaplan et al. (2006) examined children with aspecific learning and attentional problems. Both groups concluded that general motor impairments are common comorbid symptoms of attention deficits. In particular, Chaix et al. (2007) reported impaired balance and coordination in children with learning and attentional problems.

Three studies of gross motor performance in relation to externalizing behaviour have been reported (without specification of particular developmental and emotional disorders) (Bauman et al., 2004; Dewey et al., 2002; Livesey et al., 2006). Bauman et al. (2004) found motor impairment in children with externalizing problems and in children from other psychiatric subgroups. Dewey et al. (2002) found that schoolchildren with DCD showed both more externalizing behaviour and more attentional problems than their peers. Livesey et al. (2006) showed that better motor performance was correlated with less externalizing behaviour. Specifically, poor ball skills, but not poor balance, correlated with externalization.

Collectively, these studies indicate that children with ADHD exhibit poor motor performance, suggesting that externalization is associated with motor impairment. A substantial proportion of children with ADHD met the criteria or showed symptoms of comorbid DCD. Nevertheless, it is not yet clear if the subtypes of ADHD (predominantly inattentive, hyperactive–impulsive, or combined) are associated with specific motor impairments. Balance tasks are often mentioned as problematic, yet performance on ball skills might be indicative of specific subgroups. Furthermore, it is noteworthy that research on this topic in females is scarce.

Self-perception of motor competence

There are a growing number of studies of self-perception of competence in children with behavioural problems in general, but only one study of motor competence was found (Hoza, Gerdes, Hinshaw, et al., 2004). According to teacher reports, children with ADHD appeared to overestimate their athletic competence more than children without ADHD. This bias in self-perception was found in both males and females. It seems that children with ADHD inflate their self-perceptions most in domains of their greatest deficit, but comorbid depression attenuates the positive illusionary bias. Given that ADHD and DCD often co-occur, with findings indicating that the combination of the two is associated with poor psychosocial functioning in later life (Green et al., 2006; Rasmussen and Gillberg, 2000) and higher levels of depressive symptoms (Piek et al., 2007) it is surprising that no study of self-perception in groups with this comorbid condition was found.

Table III: Studies on gross motor performance and self-perception of motor competence in children with behavioural disorders

Study	Research group and inclusion	Comparison groups	Tests and scales	Findings
Gross motor performance				
Bauman et al. (2004)	102 inpatient children aged 5-13y; 79 ♂, 23 ♀; 24 externalising according to ICD-10 criteria	34 internalising, 24 externalising, 31 combined, 13 other; norm group from older study	KTK	All subgroups were below average, with no differences between subgroups
Beyer (1999)	56 ADHD all ♂ aged 7-12y from a school sample; DSM-IV criteria	56 males with learning disorder	BOTMP except for running speed and agility	ADHD children were worse on coordination and strength but not on balance
Chaix et al. (2007)	58 children with dyslexia (ICD-10 criteria) aged 8-16y; 42 ♂, 16 ♀	23 children with motor impairments, 23 motor normal, 24 children with attention impairments, 34 attention normal	LOMDS, Cancellation test, Stroop test	General motor impairments are frequent comorbid symptoms of attention deficit. Impaired balance and coordination are associated with attentional problems
Dewey et al. (2002)	174 schoolchildren aged 8-14y; 118 ♂, 56 ♀; CBCL syndrome subscales, ASQ	45 children with DCD, 51 suspected, 78 typically developing controls	BOTMP, MABC, DCDQ	DCD and suspected group display more attentional problems and externalising behaviour
Dewey et al. (2007)	27 ADHD only, 38 ADHD+DCD from school sample, 5-18y; 51 ♂, 14 ♀; DISC, DSM-IV criteria	49 children wit autism, 46 with DCD, 78 typically developing children	BOTMP - short version	Children with ADHD+DCD have worse motor performance than ADHD only and typical, but not as poor as autistic children
Hinshaw et al. (2002)	140 ADHD ♀ aged 6-12y from multiple sources; DSM-IV criteria, DISC + CBCL	93 children with ADHD-C, 47 with ADHD-I, 88 matched controls	TTD-20	ADHD-C females exhibit impaired gross motor speed

Study	Research group and inclusion	Comparison groups	Tests and scales	Findings
Kadesjö & Gillberg (1998, 1999, 2001)	409 schoolchildren aged 6-7y; 224 ♂, 185 ♀; CTRS, parent interview and child observation leading to diagnosis by authors DSM-III-R criteria	15 children with ADHD, 42 below ADHD threshold, 352 no ADHD; 20 children with severe DCD, 35 with moderate DCD	NDST-m, FBT, parent interview	DCD and ADHD are strongly associated in schoolchildren. DAMP proposed as clinically valid diagnosis
Kaplan et al. (1998)	224 children with learning and attention problems aged 8-6y; 169 ♂, 55 ♀; DISC, CBCL, ASQ / DSM-III criteria	155 typically developing children	BOTMP, MABC, DCDQ	General motor impairments are frequent comorbid symptoms of attention deficit
Livesey et al. (2006)	36 schoolchildren aged 5-6 years; 15 ♂, 21 ♀; SST, DNS, RBRI		MABC	Better motor performance is correlated with lower externalising behaviour; poor ball skills specifically predict externalisation
Miyahara et al. (2001)	47 children with ADHD from three sample sources aged 6-11 years; 38 ♂, 9 ♀; CTRS, German criteria for hyperkinetic syndrome, established by psychiatrist/psychologist	23 schoolchildren, 13 support group, 11 hospitalized children	MABC	Impaired motor performance was the lowest in the school sample. Ball skills and balance were better than manual dexterity
Piek et al. (1999)	32 children with ADHD from a community sample, aged 8-11y, all ♂; ADBS, DSM-IV criteria	16 children with ADHD-PI, 16 with ADHD-C, 16 matched controls	MABC, KST	Children with ADHD-C showed poor movement performance, especially on balance. No group differences on ball skills
Pitcher et al. (2002)	104 children with ADHD from a community sample, aged 7-12y, all ♂; ADBS, CPRS-R, DSM-IV criteria	50 children with ADHD-PI, 38 with ADHD-C, 16 with ADHD-H, 39 matched controls	MABC, tapping apparatus	Problems in force control are indicative for comorbid ADHD + DCD

Study	Research group and inclusion	Comparison groups	Tests and scales	Findings
Pitcher et al. (2003)	104 children with ADHD from a community sample, aged 7-12y all ♂; ADBS, DSM-IV criteria [a]	50 children with ADHD-PI, 38 with ADHD-C, 16 with ADHD-H, 39 matched controls	MABC	Children with ADHD-PI performed worse than those with ADHD-C, and those with ADHD-C performed worse than those with ADHD-H on ball skills. No group differences on balance
Tseng et al. (2004)	42 children with ADHD from a clinical sample, aged 6-11y; 36 ♂, 6 ♀; DSM-IV, ARP, GDS	42 matched controls	BOTMP	Children with ADHD have poor gross motor performance, especially on balance tasks
Vance et al. (2006)	37 children with ADHD-C from a clinical sample, aged 6-12 years; 34 ♂, 3 ♀; ACRS, CBCL, PACS, DSM-IV semi structured interview	20 normal controls, 20 anxiety disorder, 37 dysthymia	SDNE + parent reports	Increased motor coordination problems in children with ADHD-C
Self-perception of motor competence				
Hoza et al. (2004)	487 children with ADHD-C from the MultiModal Treatment Study, aged 7-9y, 388 ♂, 99 ♀; DISC / DSM-IV criteria	287 controls	SPCC, teacher reports	Children with ADHD appeared to overestimate their athletic competence relative to teacher reports

[a] same sample as Pitcher et al 2002; ACRS, Abbreviated Connors Rating Scale; ADBS, Australian Disruptive Behaviours Scale; ADHD, Attention Deficit Hyperactivity Disorder; ADHD-C = ADHD combined subtype; ADHD-H = ADHD hyperactive/impulsive subtype; ADHD-PI, ADHD predominantly inattentive subtype; ARP, Activity Level Rating Scales for Parents; ASQ, Abbreviated Symptom Questionnaire; BOTMP, Bruininks Oseretsky Test of Motor Performance; CBCL, Child behaviour Checklist; CPRS-R, Connors Parent Rating Scale – Revised; CTRS, Connors Teacher Rating Scale; DAMP, Deficits in Attention Motor control and Perception; DCDQ, Developmental Coordination Disorder Questionnaire; DISC, Diagnostic Interview Schedule for Children; DNS, Day Night Stroop Task; DSM, Diagnostic and Statistical Manual of Mental Disorders(III-R revised 3rd edition, IV fourth edition); FBT, Folke Bernadotte Test; GDS, Gordon Diagnostic System; KST, Test of Kinaesthetic Sensitivity; KTK, Körper Koordinationstest für Kinder (body coordination test for children); LOMDS, Lincoln Oseretsky Motor Development Scale; MABC, Movement Assessment Battery for Children; NST-m, Neurodevelopmental Screening Test – modified; PACS = Parental Account of Childhood Symptoms; RBRI, Rowe Behaviour Rating Inventory; SDNE, Scored Developmental Neurological Examination; SST, Stop Signal Task, SPCC, Self Perception Scale for Children; TTD-20, Time-to-do 20 Motor Battery

Pervasive developmental disorders

Clinical motor features

Children with PDD show stereotyped and repetitive motor mannerisms and impairments of facial expression, body postures, and gestures (APA, 1994; Page and Boucher, 1998). Children with autism, a subgroup of children with PDD, exhibit marked obsessive slowing, an increase in posturing, or stereotyped and reduced movement as a forerunner of catatonia (Ghaziuddin, Quinlan, and Ghaziuddin, 2005). Children with PDD are often characterized as clumsy and as having problems in motor coordination (Berkeley, Zittel, Pitney, and Nichols, 2001; Ghaziuddin and Butler, 1998; Piek and Dyck, 2004) but many of these children also have learning difficulties, which complicate the interpretation of their deficient motor behaviour. It is unclear whether clumsiness and poor gross motor performance are distinctive features of children with Asperger syndrome (Ghaziuddin, Butler, Tsai, Ghaziuddin 1994; Ghaziuddin, Tsai, and Ghaziuddin, 1992; Manjiviona and Prior, 1995). Hyperactivity is another frequently associated feature; high co-occurrence rates for ADHD are reported: 67.9% for PDD and even 85% for Asperger syndrome and for PDD not otherwise specified (Ghaziuddin, Weidmer-Mikhail, and Ghaziuddin, 1998; Taylor, 1994; Yoshida and Uchiyama, 2000).

Gross motor performance

Five comparative studies met the search criteria for gross motor performance in children with developmental disorders (Dewey et al., 2007; Dyck, Piek, Hay, Smith, and Hallmayer, 2006; Ghaziuddin and Butler, 1998; Miller and Ozonoff, 2000; Wisdom, Dyck, Piek, Hay, and Hallmayer, 2007). Gross motor skills were measured with the Bruininks–Oseretsky test in two of those studies (Dewey et al., 2007; Ghaziuddin and Butler, 1998), with the McCarron Assessment of Neuromuscular Development in two other studies (Dyck et al., 2006; Wisdom et al., 2007) and the Movement Assessment Battery for Children in the fifth (Miller and Ozonoff, 2000). Comparison groups varied from typically developing children to children with learning disorders, other developmental and emotional disorders, or specific subtypes of pervasive developmental disorders (Table IV).

Dewey et al. (2007) investigated children with autism spectrum disorders, who scored significantly worse on the Bruininks–Oseretsky test than typically developing children, children with ADHD, and children with DCD. However, not all children with autism spectrum disorders met the criteria for motor impairment. This could be an artefact of the use of the total test score, as this measure also covers fine motor ability. Another explanation is that gross motor problems in autism spectrum disorders are common but not universal. Ghaziuddin and Butler (1998) studied differences in motor performance between subgroups of children with autism, Asperger syndrome, or PDD not otherwise specified. All children with PDD showed motor coordination problems, but the subgroup of children with autism appeared most impaired, followed by the children with PDD, and the group with Asperger syndrome. This was true for the total battery of test scores as well as the scores on the gross motor skill subtest. However, after correction for IQ the differences between the three subgroups disappeared, indicating that IQ may have been a confounding variable. Miller and Ozonoff (2000) also showed that children with autism and Asperger syndrome exhibit below average motor abilities. Dyck et al. (2006) showed that children with autism performed far worse on gross motor tasks than typically developing children but better than children with learning disorders. Furthermore, all ability domains (i.e. motor, cognitive, social, and emotional) were unusually highly intercorrelated in children with autism. Wisdom et al. (2007) compared children with autism, mixed receptive–expressive language disorder or DCD; from the details provided, it appears that this study was performed with the same children with autism who participated in the study by Dyck et al. (2006). All groups performed below average on gross motor coordination; the autistic group performed worst, followed by the DCD group, and the mixed receptive–expressive language disorder group (respectively 3, 2, and 1 SD below typically developing children).

All five studies showed that children with PDD performed below average on gross motor tasks. They were consistently more impaired than children with ADHD, mixed receptive–expressive language disorder, or DCD. However, the assumption that specific subgroups with autism spectrum disorders perform worse in gross motor domains than others was either not confirmed or may have been due to the confounding influence of differences in IQ between subgroups.

Self-perception of motor competence

On the basis of clinical observations it has been suggested that the concept of body scheme and body awareness are both disturbed in children with autism (Steggink and Vermeer, 1997; van Loon, Aendekerk, and Verheij, 1997). Furthermore, the experience of time and space are closely linked in movement, and the ability to estimate distance is essential for adequate motor performance. In children with autism these abilities are often impaired, rendering movement situations frightening (Steggink and Vermeer, 1997). In addition, children with autism are often afraid to make physical contact, which interferes with normal play and sports behaviour. These subjective experiences may result in low perceived motor competence.

Despite these important clinical issues, no study on the self-perception of motor competence that met our selection criteria was found. One study of self-concept in 12 autistic adolescents was retrieved (Lee and Hobson, 1998) in which the authors referred to another study with 18 children (Capps, Sigman, and Yirmiya, 1995). In view of the scarce literature on this topic, these studies are briefly discussed here. Lee and Hobson (1998) used a standardized interview method and self-descriptions to measure self-concept. They found that adolescents with autism mentioned more physical characteristics but fewer physical abilities when describing themselves than typical adolescents, implying that they did not perceive themselves as deft or sporty. Capps et al. (1995) administered the Perceived Competence Scale for Children24 and noticed that children with autism perceived themselves as less competent in the physical and social domain (which suggests that they are able to make realistic evaluations of themselves) and reported lower global self-worth than typically developing children. Both studies suggest that children with autism lack confidence in participating in movement activities, which is in line with other studies (Leary and Hill, 1996; Massion, 2006; Miyahara, Tsujii, Hori, Nakanishi, Kageyama, and Sugiyama, 1997).

Table IV: Studies on gross motor performance and self-perception of motor competence in children with pervasive developmental disorders

Study	Research group and inclusion	Comparison groups	Tests and scales	Findings
Gross motor performance				
Dewey et al. (2007)	49 children with ASD from a school sample, aged 5-18y; 43 ♂, 6 ♀; DSM-IV criteria; DISC and CARS	27 children with ADHD only, 38 with ADHD+DCD, 46 with DCD, 78 typically developing children	BOTMP short form	Children with ASD had significant lower scores than other groups, even more than DCD, but 41% did not meet the criteria for motor impairment
Dyck et al. (2006)	30 children with autism from state autism register, mean age 8y6mo (SD 2y8mo); 23 ♂, 7 ♀; SCQ, ADI-R criteria	24 children with learning disorders; 449 schoolchildren	MAND	Autistic children performed worse than typically developing children but better than those with learning disorders. Motor, cognitive, social, emotional abilities were highly intercorrelated in autism
Ghaziuddin & Butler (1998)	36 children with ASD from inpatient and outpatient services; aged 6-13y 32 ♂, 4 ♀; DSM-III-R criteria, ABC	12 children with autism, 12 with AD, 12 with PDD-NOS	BOTMP total battery and gross motor subtest	All children showed motor coordination problems (total and gross motor)
Miller & Ozonoff (2000)	40 children with ASD from treatment / newsletter sample, aged 6-12y; 36 ♂, 4 ♀; DSM-IV criteria, ADI-R, ADOS	26 children with HFA, 14 with AD	MABC	Children with HFA and AD had below-average motor abilities
Wisdom et al. (2007)	30 children with autism from state autism register, aged 3-13y; 23 ♂, 7 ♀; SCQ, ADI-R criteria [a]	30 children with MRELD, 22 with DCD	MAND	All groups performed below average, the autistic group performed worst

Study	Research group and inclusion	Comparison groups	Tests and scales	Findings
Self-perception of motor competence				
Capps et al. (1995)	18 children with autism, aged 9y3mo-16y10mo; sex distribution not reported.	20 matched typically developing children	PCSC	Autistic children perceived themselves as less competent in the physical domain
Lee & Hobson (1998)	12 children with autism, aged 9-19y, 8 ♂, 4 ♀; DSM-R criteria, CARS	10 children with learning disorders	Standardised interview	Autistic children did not perceive themselves as sporty

[a] same sample as Dyck et al. (2006); ABC, Autism Behaviour Checklist; AD, Asperger Disorder; ADHD, Attention Deficit Hyperactivity Disorder; ADI-R, Autism Diagnostic Interview Revised; ADOS, Autism Diagnostic Observation Scale; ASD, Autism Spectrum Disorder; BOTMP, Bruininks Oseretsky Test of Motor Proficiency; CARS, Childhood Autism Rating Scale; DCD, Developmental Coordination Disorder; DISC = Diagnostic Interview Schedule for Children; Diagnostic and Statistical Manual of Mental Disorders(III-R revised 3rd edition, IV fourth edition), HFA, High Functioning Autism; MABC, Movement Assessment Battery for Children; MAND, McCarron Assessment of Neuromuscular Development; MRELD, Mixed Receptive Expressive Language Disorder; PCSC, Perceived Competence Scale for Children; PDD-NOS, pervasive developmental disorders not otherwise specified; SCQ = Social Communication Questionnaire.

Discussion

The present review was focused on gross motor performance and self-perception of motor competence in children with developmental and emotional disorders broadly categorized into emotional, behavioural, and pervasive developmental disorders. We will first summarize the characteristics that were found to be common across the three categories of interest and will then delineate the category specific characteristics.

Characteristics common to all categories

On average, children in all categories displayed poor gross motor skills, although individual variability was considerable. In particular, in the emotional and behavioural categories, invariably some children were found who performed rather well on tests of gross motor performance. Furthermore, poor self-concept is a widespread phenomenon in all categories. Most children with emotional, behavioural and pervasive developmental disorders are likely to perceive themselves as incompetent in motor skills, with the exception of children with ADHD who tended to overestimate their gross motor skills. Hence, motor problems were apparent in both objectively observable impaired gross motor skills and in self-perceived motor competence.

Characteristics of emotional disorders

In general, children with emotional disorders (i.e. depression and anxiety) show poor gross motor performance. The manifestation of motor problems is not very specific, although children with high anxiety may be specifically prone to balance problems (Erez et al., 2004). This finding is interesting because it is consistent with recent findings indicating a link between balance control and emotional functioning in adults, and the corresponding suggestion that neuronal networks exist that are common to both motor and emotional functioning (Kemoun, Carette, Watelain, and Floirat, 2008; Stins and Beek, 2007). In general, the causal background of the poor gross motor performance observed in children with emotional disorders is poorly understood; the study of the influence of emotions on the control and execution of movements is a much neglected area of research. In addition to poor gross motor performance, perceived motor incompetence is often observed in children with emotional problems (Cairney et al., 2007; Dewey et al., 2002; Green et al., 2006; Piek and Dyck, 2004; Piek et al., 2006; Skinner and Piek, 2001). An important yet unresolved issue in this context is whether the self-perceived motor incompetence is a direct (and logical) consequence of poor motor functioning or whether the reverse holds true.

Characteristics of behavioural disorders

Poor gross motor performance also abounds in children with behavioural disorders. In particular, two motor skills often appear to be affected: balance and ball skills. Poor performance on balance tasks is of interest, because this was also found to prevail in children with anxiety disorders. However, as children with ADHD often exhibit high levels of anxiety or even comorbid anxiety disorders, it is quite possible that high anxiety is the cause of poor balance control in these children rather than ADHD as such. This would explain why in some studies no poor balance performance was found in children with ADHD. For example, in a recent study involving children with Tourette syndrome (Lemay, Termoz, Lesperance, Chouinard, Rouleau, and Richer, 2007), ADHD symptoms had no influence on postural balance. Nevertheless, poor balance control in ADHD may also be caused by cerebellar abnormalities (Dencla, 2003; Visser, 2003). Poor performance on ball skills was often observed in children with ADHD, especially in inattentive rather than hyperkinetic subgroups (Pitcher et al., 2003). The latter is an interesting finding as it suggests that these poor skills observed in children with ADHD should be sought in more cortical-based attentional or pre-motor deficits rather than in the ineffective inhibitory action of the basal ganglia that is commonly thought to underlie the motor behaviour of children with ADHD (Bradshaw, 2001). In general, the frequently observed combination of ADHD and DCD is significant because it is associated with poor social functioning in later life and high levels of depressive symptoms (Green et al., 2004; Piek et al., 2007; Rasmussen and Gillberg, 2000). Finally, as regards self-perceived motor competence, only children with ADHD overestimate their motor competence, especially in domains of great impairment, perhaps to avoid depression.

Characteristics of pervasive developmental disorders

For children with PDD the results were unequivocal; in terms of general gross motor performance they appeared to be the most impaired of the three categories of interest, with only a very small portion of this group performing in the normal range. Characteristic of this type of disorder are the strong intercorrelations between motor, cognitive, social, and emotional impairments, which suggests the presence of a common underlying factor. One possibility is that autism is characterized by an abnormal connectivity of brain systems, rather than impairments in specific brain regions (Dyck et al., 2006). This is in line with the atypical brain development framework of Kaplan et al. mentioned earlier (Crawford et al., 2006; Gilger and Kaplan, 2001; Kaplan et al., 1998, 2001, 2006). In as far as differences were found between subgroups within this category (i.e. autism, Asperger syndrome, and PDD not otherwise specified) they appeared to be related to subgroup differences in intelligence.

Theoretical implications

The present review may be argued to have two theoretical implications, one pertaining to neurological and neuropsychological accounts of the relationships between emotional, behavioural, and pervasive developmental disorders and motor performance, and the other pertaining to the relationship between motor performance and self-perceived motor competence.

Although there are several other neurobiological models that are relevant to poor gross motor functioning (see for instance Denckla, 2003; Dewey et al.,2007; Fliers, Vermeulen, Rijdsijk et al., 2009; Piek and Dyck, 2004) we specifically highlighted atypical brain development (Crawford et al., 2006; Gilger and Kaplan, 2001; Kaplan et al., 1998, 2001, 2006) and Visser's automatization deficit hypothesis (Visser, 2003). Even though atypical brain development provides a rather coarse explanation in terms of impaired connectivity between brain structures, it appears compatible with the conclusion that PDD cannot be attributed to impairments in isolated brain structures but rather to impairments in the functioning of the brain as a whole. Some support for Visser's automatization deficit hypothesis and the related model of Erez et al. (2004) which both emphasize the role of cerebellar dysfunction, was found in the conclusion that problems in balance control are correlated primarily with high levels of anxiety. Apparently, in those children, balance skills have not been sufficiently automated during skill learning so that they are easily affected by high levels of anxiety, resulting in poor overall gross motor performance.

With regard to the relationship between gross motor performance and self-perceived motor competence, we mentioned the notion of the skill-learning gap (Wall, 2004) which refers to the vicious circle that might govern this relationship. This is of great theoretical (and practical) importance as it recognizes the possibility that poor gross motor performance of children with emotional, behavioural, and pervasive developmental disorders may lead to low self-perceived motor competence, which in turn complicates possible participation in movement activities, play, and sports, and thereby hampers experiences that may help to improve their motor performance. For example, Dewey et al. (2007) observed that children with autism may display a different pattern of impairments over their lifespan, which those authors interpreted as a reflection of individual experiences. It may well be that the aforementioned vicious circle was, in play, superimposed on the putatively common neurological cause of PDD.

Clinical implications

Of great practical (and theoretical) relevance is the observation that all subgroups are characterized by markedly poor motor performance. This finding supports the suggestion of Rasmussen and Gillberg (2000) that poor motor performance constitutes a marker for a broad range of (neuro)developmental disorders (see also Vance et al., 2006). As mentioned above, these motor impairments may have a negative effect on playing games and sports with peers, which may further hamper the psychosocial development of the child (Cairney et al., 2006; Gillberg and Kadesjö, 2003; Harvey and Reid, 2003; Massion, 2006; Piek et al., 2006; Smyth and Anderson, 2000). By consequence, children with behavioural and emotional disorders are also at risk of developing inactive lifestyles with associated chronic health problems (Cairney, Hay, Faught, Mandigo, and Flouris, 2005; Cairney, Hay, Faught, Wade et al., 2005; Cairney et al., 2006; Harvey and Reid, 2003). In view of these detrimental implications, measurement of motor performance and self-perceived motor competence should be standard practice in child psychiatry. The outcome of these measurements should guide the design of individual treatment plans. Clinicians should be alert to balance problems and perceived incompetence in children with anxiety disorders, to undercut avoidance behaviour that may hamper the psychosocial development of these children. For the same reason, it seems especially important to notice possible problems in ball skills in children with behavioural disorders, because ball skills are often social in nature. Finally, psycho-educational interventions might be helpful for children with PDD to learn to cope with motor problems and to deal with self-perceived motor incompetence.

Limitations of the present study

The most important limitations of the present study are threefold. First, the classifications of emotional, behavioural, and pervasive developmental categories suffers from inevitable overlap resulting from comorbidity (Angold et al., 1999; Gillberg et al., 2004; Kaplan et al., 1998, 2001, 2006). Second, as a consequence of the paucity of studies of some of these disorders, several studies were included that did not meet our original inclusion criteria. Third, assessment and measurement of gross motor performance and self-perceived motor competence are achieved through a variety of instruments and procedures. As a result, research findings are difficult to compare and to summarize in general terms, and the diversity and lack of incisive theoretical concepts hamper the interpretation and explanation of those findings (see also Harvey and Reid, 2003). Notwithstanding these limitations, the conclusions on the relationships between emotional, behavioural, and pervasive developmental disorders, gross motor behaviour, and self-perceived motor competence seem valid and of theoretical and clinical significance.

Future research

Inevitably, future research on this topic will remain hampered by the presence of confounding variables that may be responsible for any correlations found between specific developmental emotional, behavioural, and pervasive disorders and objective and subjective aspects of motor behaviour. Of course, attempts should be made to control, either experimentally or statistically, for those confounding variables where possible, but such control is unlikely to be complete given the multitude of variables involved. This notwithstanding, we agree with Harvey and Reid (2003) that studies of movement behaviour require several assessment batteries to understand the motor problems of children with developmental and emotional disorders in greater depth. With regard to motor performance, still no generally agreed subdivision in task domains has been accomplished (e.g. ball interception skills involve elements of both gross motor control and dexterity), rendering it important to include and correlate several subscales. Besides measures of motor performance, measures of subjective experiences, such as motivation and participation in physical activities and self-concept, should be included as a rule (see also Green et al., 2006), because psychosocial development is affected by both. Finally, we recommend that future studies address the intricate, and potentially circular, relationship between gross motor impairment and perceived motor competence with the explicit aim of delineating cause and effect.

Chapter 3

Gross motor performance and physical fitness in children with psychiatric disorders

This chapter has been published as:

Emck, C., Bosscher, R. J., Van Wieringen, P. C. W., Doreleijers, Th., and Beek, P. J. (2010). Gross motor performance and physical fitness in children with psychiatric disorders. *Developmental Medicine & Child Neurology, 53,*150-156

Abstract

Aim: Gross motor performance appears to be impaired in children with psychiatric disorders but little is known about which skill domains are affected in each disorder, nor about possible accompanying deficits in physical fitness. The present study has sought to provide information about these issues in children with emotional, behavioural, and pervasive developmental disorders (PDD).

Method: One hundred children receiving psychiatric care (81 males, 19 females, mean age 9y 11mo, SD 1y 8mo) completed both the Test of Gross Motor Development, measuring locomotion and object control, and the Motor Performance test, measuring neuromotor and aerobic fitness. The emotional disorders, behavioural disorders (BD), and PDD subgroups consisted of 17, 44 and 39 children respectively.

Results: The mean gross motor performance scores of the BD and PDD group were significantly ($p<0.05$) lower than the score of the emotional disorders group, but even the latter score was significantly lower ($p<0.05$) than the population norm score. Physical fitness was poor in all subgroups. The subdomains locomotion and object control were unusually highly correlated in the PDD group ($r=0.68$).Moreover, only in the PDD group were the locomotion scores significantly correlated with neuromotor fitness ($r=0.47$, $p=0.02$).

Interpretation: The specific combinations of impairments in gross motor skills and physical fitness in children with psychiatric disorders indicate the importance of the assessment of these domains in order to provide interventions tailored to the specific profile of each individual child.

Introduction

No one doubts the importance of gross motor skills like running, jumping, throwing, and catching for children participating in games and sports (Dewy, Kaplan, Crawford, and Wilson, 2002; Smyth and Anderson, 2000; Wall, 2004). Children who perform poorly participate less in physical activities and practice less than their peers, which may widen the skill gap and lead to activity deficits and poor physical fitness (Cairney, Hay , Faught, Wade, Corna, and Flouris, 2005; Cairney, Hay, Veldhuizen, Missiuna, and Faught, 2010; Schott, Alof, Hultsch, and Meermann, 2007; Wall, 2004).

Clinical observations suggest that many children with psychiatric disorders show impaired gross motor performance. To date, research on this topic has been predominantly confined to children with attention-deficit / hyperactivity disorders (ADHD), pervasive developmental disorders (PDD), and, to a lesser extent, emotional disorders (Dewey, Cantell, and Crawford, 2007; Emck, Bosscher, Beek, and Doreleijers, 2009; Erez, Gordon, Sever, Sadeh, and Mintz, 2004; Harvey and Reid, 2003). The majority of these studies confirmed the clinical observations: on average, children with psychiatric disorders perform worse on gross motor tests than typically developing children. However, nearly all pertinent studies reported only overall scores on motor tests and practically no scores on more specific domains of motor skill. An exception is the study of Erez et al. (2004) who reported balance skill deficits in children with anxiety disorders. Impaired gross motor skills are known to be related to poor physical fitness, which in turn is associated with impaired health status (Cairney et al., 2006, 2010; Schott et al., 2007; Runhaar, Collard, Singh, Kemper, van Mechelen, and Chinapaw, 2010). There are indications that children with ADHD often have poor physical fitness (Harvey and Reid, 2003). However, to our knowledge, no studies focussing specifically on the physical fitness of children with emotional or pervasive developmental disorders have been published to date. It thus remains unknown if gross motor impairments in children with psychiatric disorders are associated with specific fitness components, such as strength, speed, flexibility, or aerobic fitness (Runhaar et al., 2010). If so, this would be of great importance for the development of interventions.

The purpose of the present study was to determine how different aspects of gross motor performance and physical fitness are affected in three psychiatric subgroups: children with emotional disorders, behavioural disorders, and

PDD. In line with previous research (Emck et al., 2009), we expected children with PDD to show the most severe impairments in gross motor performance, followed by children with behavioural disorders and children with emotional disorders. In view of the relations between psychiatric disorders and motor problems on the one hand and between motor problems and physical fitness on the other hand, it was expected that physical fitness of children with psychiatric disorders would be low. Physical fitness was assessed with the Motor Performance test (MOPER) (Leyten, Kemper, and Verschuur, 1982) and gross motor performance was measured with the Test of Gross Motor Development (TGMD-II) (Ulrich, 2000).

Method

Participants

Between 2004 and 2007, a cross-sectional study was performed in which data were collected of 145 children, aged 6 to 12 years, with a range of psychiatric disorders from six child psychiatric centres in the Netherlands. All children were referred by their general practitioner. A registered child psychiatrist diagnosed the children according to the Diagnostic and Statistical Manual of Mental Disorders, 4th edition (APA, 1994) and informed the parents about the study. Parents received information letters, so did their children, and about two-thirds of the parents and children agreed to participate in the study. Reasons for nonparticipation were mainly of a practical nature; the parents and children in question already had too many appointments and assessments and were therefore unable to participate.

The children were tested by two trained examiners, during which the accompanying parent participated separately in the Diagnostic Interview Schedule for Children (DISC) and filled out the Children's Social Behaviour Questionnaire (CSBQ). In view of the relatively long duration of the diagnostic interview–parent version (DISC-P), the assessment was distributed across two sessions. Children who were diagnosed with both an emotional and a behavioural or other disorder were excluded, as were children for whom the clinical diagnosis could not be confirmed by the DISC or CSBQ. The final sample consisted of 100 children: 38 males and 14 females received inpatient care while 43 males and five females received outpatient care. All parents gave their written consent for participation. The study was approved by the Medical Ethics Committee of VU University Amsterdam.

Measures

Psychiatric disorders were diagnosed by means of the Dutch version of the Diagnostic Interview Schedule for Children–parent version (DISC-P) (Costello, Edelbrock, Dulcan, Kalas, and Klaric, 1984) and the Children's Social Behaviour Questionnaire (CSBQ) (Hartman, Luteijn, Serra, and Minderaa, 2006; Luteijn, Minderaa, and Jackson, 2002). The DISC-P is a highly structured parent interview for obtaining psychiatric diagnoses, except for PDD, with adequate reliability and validity (Costello et al., 1984). The CSBQ is a questionnaire for parents used for identifying specific symptom patterns of PDD. The validity and reliability of the CSBQ and its subscales are satisfactory (Hartman et al., 2006). Four out of six subscales refer to the core deficits in PDD: (1) reduced social contact and interest, (2) difficulties in understanding social information, (3) stereotyped behaviour, and (4) fear of and resistance to changes. For the present study, only children with a clinical diagnosis of PDD who scored in or above the average category for the PDD norm group on at least three of the four subscales were classified as PDD.

Gross motor performance was measured with the TGMD-II (Ulrich, 2000). According to the manual, reliability and validity of the TGMD-II are adequate (Ulrich, 2000). The test entails two subtests, locomotion and object control, each based on six separate skills. The locomotion skills are: run, gallop, hop, leap, horizontal jump, and slide. The object control skills are: striking a stationary ball, stationary dribble, catch, kick, overhand throw, and underhand roll. Raw scores are converted to standard scores (mean 10, SD 3), age equivalents, and to an overall Gross Motor Quotient (GMQ: mean 100, SD 15). Norm scores are available for both males and females aged 3 to 11 years. Because no significant differences were found in GMQ, locomotion, or object control between 11- and 12-year-old children compared to 9- and 10-year-old children, we used the norms for the 9- and 10-year-old children for the older children as well.

Physical fitness was measured by the MOPER (Leyten et al., 1982) which consists of items that measure different aspects of neuromotor and aerobic fitness. Strength measurements were the 'flexed arm hang' (the maximal time that the participants' eyes are above a horizontal bar in a hanging position), the 'standing high jump' (the maximal jumping height in metres, measured with a jump board, measuring tape, and belt), and 'ten leg lifts' (the time in seconds needed to lift the legs 10 times from the horizontal to vertical position with extended knees). Speed measurements were 'ten times 5m sprint' (the time in seconds needed to run 10 times between two lines, placed 5m apart) and 'plate tapping' (the time in seconds needed to tap 50 times with the participants' preferred hand between two plates positioned 75cm apart). The flexibility measurement was a 'sit and reach test' (the maximal reach in centimetres in the sitting position with extended knees). Apart from these neuromotor tasks, aerobic fitness was measured using the 'six-minute run', in which the child ran around a 150m court. The distance covered during 6 minutes was registered.

Norm scores were provided in 1982 for Dutch children aged 9, 10, and 11 (males and females separately); the category scores (1–5) relate to quintiles with regard to the population norms. The reliability and validity of each subtest were adequate (Leyten et al., 2000). Although an overall score is sometimes used as an indicator of neuromotor fitness, no norm scores for this variable are available. Therefore, confining the analysis to the participants in the age range of 9 to 11 years, we used the mean of the category scores on the six neuromotor items as an indicator of neuromotor fitness (neuromotor score, range 1–5). Furthermore, the mean category score of arm hang, high jump, and leg lift was used as an indicator of overall strength, while the mean category score of running speed and plate tapping was used as an indicator of overall speed. Although using norms dating back from 1982 poses no problem for comparisons between groups and for correlational analyses, it may be problematic if comparisons are made with typically developing children given a worldwide decline in physical fitness of children since the 1980s (Tomkinson, 2007). Therefore, we also compared the raw MOPER fitness scores with recent scores from a large Dutch community sample of 9- to 11-year-old children (Runhaar et al., 2010). These scores were available for the neuromotor fitness subtests, but not for the 6-minute run indicating aerobic fitness.

Subgroups

For the analysis at group level we constructed three groups: (1) emotional disorders, this group consisted of children diagnosed with at least one DISC anxiety disorder and ⁄ or a dysthymic or depressive disorder, (2) behavioural disorders, consisting of children with DISC diagnoses ADHD, oppositional defiant disorder, and ⁄ or conduct disorder, (3) PDD, this group consisted of children with CSBQ-diagnosed PDD.

Statistical analysis

Means and standard deviations are provided for the main dependent variables (GMQ, locomotion and object control standard scores, developmental delay of locomotion and object control, neuromotor fitness, overall strength, overall speed, and MOPER subtest scores). A ‘motor delay’ score for locomotion and object control was computed to assess the developmental delay (real age minus gross motor age equivalent).

To compare the participants with children in the normal population, one-sample t-test was performed and effect sizes were calculated using $r_{es} = \sqrt{\left(t^2/\left(t^2 + df\right)\right)}$. Effect sizes were interpreted as large when $r_{es} \geq 0.50$ (Cohen, 1992). Since Levene’s tests showed no violations in the parametric assumptions about the distribution of the data in the subgroups ($p > 0.05$), differences between subgroups were analysed by means of ANOVA. Differences between each of the three subgroups were analysed by Games-Howell tests, because these post-hoc tests are regarded as the most accurate and powerful ones available in case of unequal sample sizes (Field, 2005). Correlations between locomotion and object control scores were calculated, followed by Fisher *r*-to-*z* transformation to compare correlation coefficients within the subgroups with those within the norm sample (Ulrich, 2000).

For subgroups, correlations were computed between MOPER scores (neuromotor fitness, overall speed, and overall strength) and TGMD-II measures (GMQ, locomotion, and object control). Finally, for the boys aged 9 to 11 years, pooled variance estimate t-tests were performed on MOPER neuromotor fitness subtests to compare the mean scores per age group with the mean scores of a community sample recently provided by Runhaar et al. (2010). As no data of this sample were available for the 6-minute run, comparisons for the aerobic fitness subtests were not made. The number of participants in our sample was too small to consider the diagnostic groups separately within each age band; hence the comparisons were only made at the level of the psychiatric group as a whole.

Table I: Participants and subgroups

	N	Males/ females	Mean age (SD), y:mo	N (%) inpatients	Medication, n (%)		
					Methyl-phenidate	Mela-tonin	atypical antipsychotics
ED	17	12/5	10:6 (1:6)	6 (35)	0	0	0
BD	44	39/5	9:10 (1:10)	25 (57)	8 (18)	3 (7)	2 (4.5)
PDD	39	30/9	9:8 (1:7)	21 (54)	7 (18)	8 (21)	10 (31)
Total	100	81/19	9:11 (1:8)	52 (52)	15 (15)	11 (11)	12 (12)

ED = emotional disorders, BD = behavioural disorders, PDD = pervasive developmental disorders

Runhaar et al. (2010). As no data of this sample were available for the 6-minute run, comparisons for the aerobic fitness subtests were not made. The number of participants in our sample was too small to consider the diagnostic groups separately within each age band; hence the comparisons were only made at the level of the psychiatric group as a whole.

Results

Descriptive information about sex, distribution of inpatients and outpatients and the use of medication across the subgroups is presented in Table I. Males and females did not differ significantly in age ($t(98)=0.66$, $p>0.10$). There were neither significant differences between the subgroups, emotional disorders, behavioural disorders and PDD with regard to age ($F_{2,97}=1.6$, $p>0.10$) nor with regard to the number of inpatients and outpatients ($\chi^2(2)=2.36$, $p=0.307$; Table I).

Table II: GMQ, locomotion and object control on Test of Gross Motor Development for each subgroup

	Emotional disorders (*n* = 17)				Behavioural disorders (*n* = 44)				Pervasive developmental disorders (*n* = 39)			
	Mean (SD)	***t***	***p***	r_{res}	**Mean (SD)**	***t***	***p***	r_{res}	**Mean (SD)**	***t***	***p***	r_{res}
GMQ[a]	89.94 (11.0)	3.76	.002	.68	80.50 (14.58)	8.87	.000	.80	77.54 (17.6)	7.97	.000	.79
Locomotion [a]	8.53 (2.45)	2.47	.025	.53	6.73 (2.94)	7.37	.000	.75	6.10 (2.90)	8.39	.000	.81
Object control[a]	8.12 (2.83)	2.75	.014	.56	6.91 (3.06)	6.70	.000	.71	6.44 (3.49)	6.39	.000	.72
Locomotion & object[b]	-0.04				.35[c]				.68[d]			
Delay locomotion	2;7 (2;4)				3;5 (2;7)				3;6 (2;6)			
Delay object control	2;8 (1;10)				2;11 (2;4)				2;11 (2;8)			

[a]*Mean scores on Gross Motor Quotient (GMQ), locomotion, and object control for each subgroup, followed by t-values indicating the difference with the population means.* [b]*Pearson correlations between locomotion and object control scores. Developmental delays in years and months with respect to locomotion, and object control for each subgroup. Population mean GMQ=100 (SD 15); population mean standard scores locomotion and object control=10 (SD 3).* [c]*$p<0.05$,* [d]*$p<0.01$.*

Mean GMQ, locomotion, and object control scores of all subgroups differed significantly from the norm population (Table II). Subgroups differed in GMQ ($F_{2,97}$=3.90, *p*=0.023); the emotional disorders group had a significantly higher GMQ than both the behavioural disorders group (*p*=0.025) and the PDD group (*p*=0.007). Subgroups differed on the locomotion subtest ($F_{2,97}$=4.31, *p*=0.02); the emotional disorders group scored significantly better than the PDD group (*p*=0.008) and the behavioural disorders group (*p*=0.05). No significant differences between subgroups were found for object control ($F_{2,97}$=1.64, *p*=0.20). Locomotion and object control scores were significantly correlated in the behavioural disorders and PDD group, but not in the emotional disorders group. The correlation coefficient in the PDD group differed significantly from those in the norm group (*z*=2.31, *p*=0.02), the emotional disorders group (*z*=2.76, *p*=0.01), and the behavioural disorders group (*z*=2.03, *p*=0.04). All subgroups showed marked delays in motor development for about 3 years.

For the MOPER, only data of the children aged 9 to 11 years (*n*=53, 43 males, 10 females) were analysed. All subgroups scored below average (<3) on all fitness subtests (Table III). No significant differences in neuromotor fitness between the subgroups were found ($F_{2,50}$=2.3, *p*=0.11). Analyses for emotional disorders and behavioural disorders separately showed no significant correlations between MOPER (overall neuromotor fitness, overall speed, overall strength) and TGMD-II measures (GMQ, locomotion, object control). However, in the PDD group the overall neuromotor score correlated significantly with locomotion (*r*=0.47, p=0.02), and a trend towards significance was found for the correlation with GMQ (*r*=0.40, *p*=0.07). Furthermore, in the PDD group GMQ was significantly correlated with overall strength (*r*=0.52, *p*=0.02).

Table III: Mean and standard deviation of subtest scores on Motor Performance for each subgroup

	Emotional disorders (*n*=12)	**Behavioural disorders (*n*=20)**	**Pervasive developmental disorders (*n*=21)**
Neuromotor fitness	2.0 (0.6)	1.7 (0.6)	1.6 (0.5)
Overall strength	1.9 (0.8)	1.5 (0.6)	1.6 (0.6)
Arm hang	1.3 (0.4)	1.2 (0.4)	1.3 (0.6)
Standing high jump	2.6 (1.6)	1.6 (0.9)	2.2 (1.5)
Legs lift	2.1 (1.6)	1.8 (1.5)	1.4 (0.8)
Overall speed	2.2 (1.1)	1.8 (0.9)	1.5 (0.7)
Running speed	1.8 (1.3)	1.3 (0.8)	1.1 (0.3)
Plate tapping	2.6 (1.6)	2.3 (1.4)	1.9 (1.3)
Flexibility: sit and reach	2.1 (1.6)	2.0 (1.3)	1.9 (1.2)
Aerobic fitness (6-min run)	1.0 (0.0)	1.1 (0.3)	1.0 (0.0)

Score: 1 = low, 2 = below average, 3 = average, 4 = above average, 5 = high; each category represents 20% of the norm population.

Compared to the sample studied by Runhaar et al. (2010), the males in our sample performed significantly worse on neuromotor fitness subtests, except for leg lift in all age groups, plate tapping in 10- and 11-year-olds, and sit and reach in 9- and 10-year-olds (Table IV).

Table IV: Mean and standard deviation scores on the Motor Performance test fitness items for 9- to 11-year-old males in research group and sample of Runhaar et al. (2009)

	Males 9-year-old			Males 10-year-old			Males 11-year-old		
	Psy	R group	t_p	Psy	R group	t_p	Psy	R group	t_p
Arm hang in s *n*	2.9 (2.0) 14	10.0 (9.6) 51	2.74[a]	2.8 (4.0) 11	12.9 (12.1) 356	2.76[a]	5.3 (6.0) 18	12.5(9.4) 444	3.22[a]
High Jump in cm *n*	25.9 (5.3) 14	34.2 (6.3) 50	4.50[a]	29.8 (5.2) 11	36.8 (5.7) 358	4.02[a]	31.2 (5.2) 17	38.7(6.6) 444	4.63[a]
10 legs lift in s *N*	20.5 (7.5) 14	18.0 (5.6) 49	0.14[ns]	19.6 (6.9) 11	17.9 (6.4) 356	.87[ns]	18.2 (4.5) 17	18.4(6.7) 433	0.12[ns]
Running 5m in s *N*	22.8 (2.1) 14	20.2 (1.9) 50	4.42[a]	22.2 (3.1) 11	19.7 (1.5) 361	5.22[a]	21.2 (1.9) 18	19.4(1.6) 442	4.52[a]
Plate tapping in s *N*	18.9 (2.9) 14	16.0 (1.7) 50	4.77[a]	16.1 (2.8) 11	15.6 (1.8) 357	.89[ns]	14.9 (2.7) 18	14.8(1.7) 441	0.24[ns]
Sit and reach in cm *N*	26.1 (5.9) 14	28.1 (7.3) 51	0.94[ns]	23.6 (6.0) 11	27.0 (6.4) 359	1.74[ns]	19.8 (8.6) 18	25.4(6.8) 440	3.39[a]
6min run in m		No data			No data			No data	

a $p < .01$. For arm hang, high jump, sit and reach a higher scores indicate better performance; for legs lift, running speed and plate tapping lower scores indicate better performance. No data on 6-min run were available for the sample of Runhaar et al. (2009). Psy = research group children with psychiatric disorders; R group = sample of Runhaar et al. (2009), t_p pooled variance estimate t-test.

Discussion

The aim of this study was to examine which aspects of gross motor performance and physical fitness are affected in children with psychiatric disorders. Large effect sizes of each disorder on gross motor performance were found that amounted to a developmental delay of approximately 3 years for both locomotion and object control, indicating that the psychiatric group performed significantly worse than typically developing children. Furthermore, children with psychiatric disorders were characterized by poor neuromotor and aerobic fitness. Although these findings pertained to all subgroups, some remarkable differences were present.

As expected, children with emotional disorders were less impaired in gross motor skills than children with behavioural disorders or PDD. Interestingly, and in contrast to healthy children (Ulrich, 2000), locomotion and object control were unrelated, suggesting that children with emotional disorders show variable patterns of gross motor impairments. Since a neurologically based connection between balance dysfunction and anxiety in children has recently been documented (Bart, Bar-Haim, Weizman, Levin, Sadeh, and Mintz, 2008; Erez et al., 2004), these variable patterns might be due to differential effects of balance problems on locomotion and object control. Although the emotional disorders group performed better than the other subgroups on gross motor performance, they did not show higher physical fitness scores. Unfortunately, however, it could not be definitely ascertained whether the low fitness scores in the emotional disorders group really reflected low physical fitness. They might also have been due to subjective perceptions of low energy and self-defeating thoughts (Sukumaran, Vickers, Yates, and Garralda, 2003) resulting in a reduced motivation to participate in tasks that require effort and perseverance, like the MOPER. However, if children habitually fail to spend effort and to persist in physical activities, lower physical fitness might emerge as a consequence.

As expected, the PDD group showed the largest gross motor impairment of all subgroups in both locomotion and object control. Remarkably, the scores in these subdomains were significantly higher correlated in this subgroup than in the other subgroups and in typically developing children. Moreover, significant correlations between TGMD-II and MOPER measures were only found in the PDD group. These results are in agreement with earlier findings indicating abnormally high correlations between ability domains in children with PDD which have been tentatively interpreted as reflecting an underlying impairment in the development of connectivity of brain systems (Dyck, Piek, Hay, Smith, and Hallmayer, 2006).

Our expectation that children with behavioural disorders would perform better than children with PDD, but worse than children with emotional disorders was only partially confirmed. Gross motor performance was indeed more impaired in the emotional disorders than in the behavioural disorders groups, but the difference between the behavioural disorders group and the PDD group was not significant. Also, the effect sizes (0.80 and 0.79) were almost the same in behavioural disorders group and PDD group, as was the developmental delay in locomotion and object control. These findings illustrate the phenotypic similarities of these two groups and testify to the appropriateness of the ongoing debate whether these groups represent ecologically valid categories (Hattori, Ogino, Abiru, Nakano, Oka, and Ohtsuka, 2006; Mulligan, Anney, O'Regan et al., 2008). However, while locomotion and object control were strongly interrelated in the PDD group, their correlation in the behavioural disorders group fell within the normal range (between 0.34 and 0.48) (Ulrich, 2000). In this respect, the behavioural disorders group appeared more similar to typically developing children than to the PDD group, suggesting that the underlying neurodevelopmental mechanisms of these groups may be different.

Three limitations of the present study should be mentioned. First, some of the children were on medication. However, no adverse effects of the types of medication on gross motor performance are known. On the contrary, methylphenidate, used by 18% of the children in the behavioural disorders and PDD groups, might have led to better motor performance as a consequence of improved concentration on the gross motor tasks, thus leading to an underestimation of the gross motor impairment in these two groups. Second, we used the TGMD-II norms for 9- to 10-year olds for 11- to-12-year-old children as well. The fact, however, that the older children did not even live up to those norms highlights the significance of their motor problems. Third, although the MOPER fitness test is a widely used instrument to study physical fitness in children, the available norm data were outdated, which limited the interpretation of some of the results. In recognition of this problem, however, we also compared our data to recently published data of a community sample (Runhaar et al., 2009) and the results again confirmed our hypothesis that physical fitness in psychiatric children is typically rather poor.

This study shows that gross motor performance needs attention in child psychiatric practice regardless of the specific type of disorder. We therefore recommend a standard gross motor assessment for all children who receive psychiatric care in order to provide interventions tailored to the specific symptom profile of each individual child. If gross motor problems remain unnoticed, a widening skill-learning gap is likely to occur, which may hamper psychosocial development even further, which in turn may have negative influences on the course of the psychiatric disorder. Therefore, longitudinal studies, such as recently published by Cairney et al. (2010), are needed to track the development of gross motor performance and physical fitness in children with psychiatric disorders. Furthermore, in view of the low physical fitness of children attending psychiatric care, it is of great importance to enhance daily activity levels to prevent secondary health problems in these children in the long run.

Chapter 4

Patterns of postural sway in high anxious children

This chapter was published as:

Stins, J.F. Ledebt, A., Emck, C., van Dokkum E.H., and Beek, P.J. (2009). Patterns of postural sway in high anxious children. *Behavioral and Brain Functions*, *5*:42

Abstract

Background: Current research suggests that elevated levels of anxiety have a negative impact on the regulation of balance. However, most studies to date examined only global balance performance, with little attention to the way body posture is organized in space and time. The aim of this study is to examine whether posturographic measures can reveal (sub)clinical balance deficits in children with high levels of anxiety.

Method: We examined the spatio-temporal structure of the centre-of-pressure (COP) fluctuations in children with elevated levels of anxiety and a group of typically developing children while maintaining quiet stance on a force plate in various balance challenging conditions. Balance was challenged by adopting sensory manipulations (standing with eyes closed and/or standing on a foam surface) and using a cognitive manipulation (dual-tasking).

Results: Across groups, postural performance was strongly influenced by the sensory manipulations, and hardly by the cognitive manipulation. We also found that children with anxiety had overall more postural sway, and that their postural sway was overall less complex than sway of typically developing children. The postural differences between groups were present even in the simple baseline condition, and the group differences became larger with increasing task difficulty.

Conclusion: The pattern of postural sway suggests that balance is overall less stable and more attention demanding in children with anxiety than typically developing children. The findings provide further evidence for a neuro-behavioural link between psychopathology and the effectiveness of postural control.

Background

The control of quiet upright stance is accomplished through a delicately orchestrated activation of the musculoskeletal system, which involves a combination of vestibular, visual, and somato-sensory inputs (see Horlings, Küng, Bloem et al., 2008). These inputs are part of neural feedback mechanisms that operate through, and along, the spinal cord and the brainstem for the purpose of balance control (Loram, Maganaris, and Lakie, 2005). Furthermore, various higher brain structures like basal ganglia, cerebellum and cortex are implicated in balance control (for a review, see Lalonde and Strazielle, 2007). Disturbances in any of the systems that govern balance may result in balance disorders, e.g., due to reduced vestibular functioning or due to problems with the regulation of tonic motor output. Perhaps surprisingly, balance disturbances can also result from excessive activity in limbic structures that subserve emotionality, in particular fear and anxiety. Several studies have found impaired balance in individuals with anxiety disorders and, conversely, elevated levels of anxiety among individuals with vestibular disorders (Balaban and Jacob, 2001; Kogan, Lidor, Bart, Bar-Haim, and Mintz, 2008; Sklare, Konrad, Maser, and Jacob, 2001). These patterns of comorbidity suggest that balance disorders and anxiety disorders share a common pathology. As argued in the literature (e.g. Balaban, 2002; Balaban and Thayer, 2001), this comorbidity is likely mediated by shared neural circuits, in particular the parabrachial nucleus network. The parabrachial nucleus is a major brain stem relay centre for visceral information that includes a vestibulo-recipient region as well as projections to the vestibular nuclei. It has also reciprocal connections with the central amygdaloid nucleus and has been frequently cited as a substrate for anxiety and panic disorders (Balaban, 2002).

If there is indeed a link between the neural structures that govern balance and those that govern anxiety, then balance disorders may - in principle - benefit from interventions aimed at reducing anxiety. Conversely, individuals with anxiety disorders should benefit to some extent from balance training. As a case in point, it was recently shown that a program involving 12 weekly sessions involving balance training resulted not only in improved balance, but also in reduced anxiety and higher self-esteem in a group of children with comorbid balance disorders and elevated levels of anxiety (Bart, Bar-Haim, Weizman, Levin, Sadeh, and Mintz, 2009). A thorough understanding of the interaction between balance and anxiety in children is especially needed as children continue to develop, and their pathology may start a cycle involving

avoidance of balance challenging situations (e.g., on the playground), fewer social and physical encounters, and increased risk of anxiety (Erez, Gordon, Sever, Sadeh, and Mintz, 2004). But only very few studies have examined postural performance in a group of children with anxiety disorders. It was found (Erez et al., 2004) that this group of children made more balance mistakes than controls on a wide variety of balance tests, such as walking on a rope. However, no group differences were found in less challenging situations, such as standing heel-to-toe for a certain amount of time. Erez et al. (2004) also found elevated levels of dizziness and sensitivity to motion sickness in their clinical sample, although neurological examination revealed no vestibular impairment. It was concluded that childhood anxiety is characterized by subclinical levels of balance disorder.
Further insight into the interaction between balance and anxiety in children can be gained by using posturographic measures that capture the fine-grained spatio-temporal structure of the naturally occurring body sway during quiet stance. Analysis of the center of pressure (COP) time series can be used to reveal essential properties of the balance system, such as its overall stability, its regularity and complexity, and the attentional involvement in balance regulation, all of which have been considered markers of the quality of postural performance (Prieto, Myklebust, Hoffmann, Lovett, and Myklebust, 1996; Richman and Moorman, 2000; Roerdink, de Haart, Daffertshofer, Donker, Geurts, and Beek, 2006). To our knowledge, only two studies have examined postural regulation using a force platform in a child psychiatric population (Buderath, Gärtner, Frings et al., 2009; Lemay, Termoz, Lesperance, Chouinard, Rouleau, and Richer, 2007). In one study (Lemay et al., 2007), postural regulation in children with Gilles-de-la-Tourette syndrome (TS) was examined. That study found an increase in sway area and an increase in sway velocity in the TS group relative to typically developing children, regardless of whether the eyes of the participants were open or closed during stance. The other study (Buderath et al., 2009) examined children with attention deficit/hyperactivity disorder (ADHD), and here mild postural abnormalities (increased sway area) and mild gait abnormalities were found, regardless of ADHD subtype.

The present research focuses on the interface of childhood anxiety and balance regulation, by means of posturographic measurements. We examined postural performance of a group of children with (sub)clinical anxiety levels under various conditions where balance was challenged. The aim was to reveal which balance parameters related to sway magnitude, sway velocity, and complexity of postural sway would reveal group differences in postural regulation during quiet standing. Our main hypotheses were that the postural sway of high anxious children would (a) have overall greater magnitude (suggestive of lower stability, e.g. Schmit, Regis, and Riley, 2005), (b) have overall greater velocity (suggestive of greater open-loop control, e.g. Deconinck, De Clercq, Van Coster et al., 2007), and (c) be less complex than the sway of typically developing children. With respect to the latter, there is an emerging view that complexity of physiological time series such as cardiovascular time series (Richman and Moorman, 2000) and COP fluctuations (e.g. Roerdink et al., 2006) is indicative of the capacity of the system to adapt to a constantly changing environment (see Duarte and Sternad, 2008). Complexity can be thought of as reflecting the information content (entropy) in a time series, and recent studies have shown that postural sway in pathologies such as stroke (Roerdink et al., 2007) and cerebral concussion (Cavanaugh, Guskiewics, Giuliani, Marshall, Mercer, and Stergiou, 2006) is indeed characterized by lower entropy than that of controls. As argued by some (Roerdink et al., 2007; Donker, Ledebt, Roerdink, Savelsbergh, Beek, 2008; Donker, Roerdink, Greven, and Beek, 2007) it could be that reduced entropy reflects the extent to which actors invest attention in their maintenance of posture, which under normal circumstances takes place in a nearly automatic fashion. Based on these considerations we predicted that the reduced postural capabilities of anxious children become manifested as lower complexity in the time series of their posturograms.

In addition, we examined the prediction following from an earlier study (Erez et al., 2004) that putative group differences become even more apparent when balance is challenged (for comparable findings with a group of children with Developmental Coordination Disorder see Geuze, 2003). To this end, balance was challenged by increasing the task difficulty in three different ways, namely by removing vision, by having participants stand on a compliant surface (e.g. Patel, Fransson, Lush, and Gomez, 2008), and by imposing an attention-demanding cognitive task. Based on findings that adults with increased anxiety levels have greater reliance on visual information for balance (Redfern, Furman, and Jacob, 2007), we predicted that especially our sample of high anxious children would show excessive sway when no vision was available.

Method

Participants

Eleven children (8 males, 3 females, mean age: 10.3 yr., SD: 1.2, range 8-12) were recruited at Symfora Group Fornhese, a psychiatric unit for child and youth psychiatry in Amersfoort, the Netherlands. The children were referred to this unit by their general practitioner for diagnosis

and treatment for various psychiatric problems, possibly related to ADHD or Obsessive Compulsive Disorder (OCD). Inclusion in the present study was based on the outcome score in the borderline or clinical range of the anxiety/depression scale of the Dutch version of the Child Behaviour Checklist (CBCL; Achenbach and Rescorla, 2001; see below) that was administered as part of the standard procedure at admission in the unit. Exclusion criteria were physical limitations that might influence the balance measurements, and an IQ-score below 80. At the time of testing, psychiatric diagnosis was still not fully established. Thirteen typically developing children (4 males, 9 females, mean age: 10.1 yr., SD: 1.3, range 8-12), without known (sub)clinical anxiety levels or psychiatric disorders served as a control group. The study was approved by the local ethics committee before it was conducted.

Procedure and apparatus

Balance and anxiety measures were completed at Fornhese (anxiety group [AN]) and at the Faculty of Human Movement Sciences (typically developing group [TD]). Parents gave written informed consent and children assented to participate in the study. The CBCL was completed once more by the participants' parents within a few days following the day of testing. Participants stood barefoot on a 1 × 1 m custom made strain gauge force plate, with their arms hanging relaxed alongside their body. On all trials the same foot placement was adopted (heels 8.4 cm apart, toes pointing outward at an angle of 9 degrees from the sagittal midline). The postural sway of the participants was registered while they performed three different tasks: standing with no additional challenge; baseline (BS), standing on a compliant surface (foam; 40 × 40 × 8 cm, medium density) (Foam Standing; FS), and standing while performing a cognitive dual task (DT). All conditions were performed with eyes open (EO) and eyes closed (EC), giving rise to six conditions. Each of these conditions was repeated 5 times, resulting in a total of 30 trials per participant, presented in fully randomized order. Between each block of 6 trials a small break was given, during which participants were able to freely move and walk around. Participants were instructed to maintain quiet stance during the measurements. During eyes open trials, participants were instructed to focus on a drawing located at eye level, 1.5 m in front of them. The dual task consisted of a memory task. During these trials, participants had to listen to a list of animal names. The words were presented at a frequency of 0.5 Hz, which resulted in a total number of twelve different animal names per trial. Participants were instructed to fully concentrate on the names and to memorize as many of the names as they could. After completion of the DT trial, participants verbally reported the animal names they remembered. The number of correctly remembered items was scored by the experimenter. COP data were collected for 20 s at a sample frequency of 200 Hz. The data collection started after the participant stood still for five seconds. An experimenter stood behind the participant during all trials for safety reasons.

Anxiety measures

In order to assess the level of anxiety two different measures were used. The level of experienced (state) anxiety of the participant was examined by asking participants to scale their current anxiety level immediately prior to the experiment on an anxiety thermometer. The anxiety thermometer runs from 0 to 10, with 0 corresponding to 'no anxiety' and 10 to 'extremely frightened' (Houtman and Bakker, 1989).

In addition, we assessed trait anxiety a few days following testing based on the scores of the Dutch version of the Child Behaviour Check List. The CBCL is a parent-rating scale to assess various aspects of behaviour and psychopathology in childhood. The test-retest reliability of the CBCL and the internal consistency of the scales are both good (for details see Achenbach and Rescorla, 2001). The CBCL consists of two scales; a social competence scale and a behaviour problem scale. Only the behaviour problem scale was used for our purposes. The behaviour problem scale consists of 113 items describing possible behaviours that the child may or may not exhibit. The items are grouped in eight different syndrome scales, and we focused on the scores of the anxious/depressed sub-scale. The calculated scores of each domain can be classified as 'normal ' (T-scores ≤ 59), 'borderline' (60 ≤ T-scores ≤ 63), or 'clinical range' (T-scores ≥ 64). Scores in the borderline range are often considered high enough to be of concern.

Posturographic data analysis

The continuous displacement of the COP was calculated in x (medio-lateral [ML]) and y (anterior-posterior [AP]) directions. Prior to all analyses the mean was subtracted from both medio-lateral and anterior-posterior COP trajectories to correct for offset. The posturographic time series were bi-directionally filtered (2nd order low pass Butterworth filter, cut-off frequency of 12.5 Hz). In addition the radial component, or resultant distance (r), was calculated following $r_i = \sqrt{x_i^2 + y_i^2}$ (Prieto et al., 1996), with i = 1, 2, 3, ..., N and N indicating the total number of data points in the COP time series (i.e., 3999).

The amount of postural sway was quantified by means of the sway area (SA), a statistically based estimate of a confidence ellipse that encloses approximately 95% of the points of the COP trajectory. The ellipse was calculated using the following equation:

$$SA = 2\pi F_{.05[2,N-2]}\sqrt{s_{AP}^2 s_{ML}^2 - s_{APML}^2}$$

where $F_{.05[2,N-2]}$ is the F statistic at a 95% confidence level for a bivariate distribution with N data points. If N is > 120, F is 3.00. S_{AP} and S_{ML} are the standard deviations of the AP and ML time series respectively, while S_{APML} represents their covariance (Prieto et al., 1996). Average sway velocity was determined by calculating the sum of the COP displacements in the AP-ML plane over a trial (i.e., the sway path length) and dividing this number by the recording time, i.e., 60 s.

To examine the structure of the COP trajectories independent of its size or scale, x and y were normalized to unit variance by dividing the time series by their respective standard deviations. The sway path length calculated over this normalized posturogram provides a scale free measure of the amount of 'twisting and turning', in which larger SP_n values indicate more twisting and turning (Donker et al., 2007). This measure is thus related to the spatial complexity of the COP time series:

$$SP_n = \sum_{i=1}^{N-1}\sqrt{\left(x_{i+1} - x_i\right)^2 + \left(y_{i+1} - y\right)^2}$$

Finally, to gain insight into the complexity of the time series we calculated the sample entropy. The sample entropy (SampEn) in a set of data points is the negative natural logarithm of the conditional probability that a sequence of data points with length N, having repeated itself within a tolerance t for M

points, will also repeat itself for $M + 1$ points, without allowing self-matches (Richman and Moorman, 2000). SampEn provides information about the regularity of a time-series, whereby a decrease in SampEn values implies an increase in regularity. Low regularity has been associated with a more flexible and healthy pattern, as healthy physiological systems (e.g., the human heart) are often characterized by an irregular and complex type of variability (Richman and Moorman, 2000; Duarte, and Sternad, 2008) whereas in the presence of pathology or aging more regular (and thus less complex) behaviour can be observed (Donker et al., 2008; Donker et al., 2007; Pincus and Goldberger, 1994; Roerdink et al., 2006). SampEn was calculated on the radial COP components, normalized to unit variance. SampEn software was obtained from PhysioNet. Parameter values of M ($M = 3$) and t ($t = 0.05\sigma$) were based on earlier studies (Lake, Richman, Griffin, and Moorman, 2002; Roerdink et al., 2006) to find optimum values for these parameters.

Statistical analysis

The posturographic data of all dependent measures were averaged over the five trials of each condition. A repeated measures analysis of variance (ANOVA) was used with within-subject factors task (3 levels: BS, FS, and DT) and vision (2 levels: EO and EC), and group (AN and TD) as the between subject factors on postural sway parameters. Possible interactions were explored using follow-up analyses.

Independent-samples *t*-tests were performed to test for differences between the experimental and the control group on (a) the anxiety thermometer scores, (b) scores of the anxiety/depression scale of the CBCL, and (c) performance on the memory task (number of correctly recalled items). For all analyses we adopted a *p*-value of .05.

Results

Data evaluation

The data of two participants, both from the TD group, had to be excluded from the study; the posturographic data of one child showed unexplainable artefacts, while the other child showed elevated levels of anxiety on the anxiety measures. Furthermore, three AN children lost their stability on one occasion in the foam condition. These trials were excluded from the posturographic analyses.

Anxiety measures
Statistical analyses of the CBCL did show a significant difference between the anxiety and control group on the 'anxious/depressed' scale, $t(20) = 5.701$, $p < .001$, whereby the anxiety group scored in the clinical range (mean 65.2; SD 5.9), whereas all children in the TD group scored in the normal range (mean 52.2; SD 4.4). There were no significant differences between the anxiety levels of groups on the anxiety thermometer ($t(20) = 0.539$, $p > .1$). As the groups did not differ in experienced state anxiety before the onset of the experiment, possible posturographic differences may therefore be due to differences in stable subject characteristics.

Memory performance
Children in the AN group recalled significantly fewer items than children in the TD group, $t(20) = 2.920$, $p < .01$ (mean 4.2 vs. 5.8 items, respectively).

Posturographic measures
Amount of sway
Main effects of group, $F(1, 20) = 16.847$, $p < .001$, task, $F(2, 40) = 45.850$, $p < .001$, and vision, $F(1, 20) = 17.064$, $p < .001$, were found. The main effect of group indicated that sway area was overall larger for the AN group than the TD group. The main effect of task was due to significantly elevated levels of postural sway in the foam condition, compared to the baseline and cognitive dual task condition. Also, removal of vision led to increased postural sway.
In addition to these main effects significant two-way interactions were found, Task × Vision, $F(2, 40) = 43.373$, $p < .001$, and Task × Group, $F(2, 40) = 7.590$, $p < .001$. The first can be explained by the fact that removal of vision resulted in a larger sway area, but mainly when participants stood on foam. The second revealed that both groups responded differently to the task manipulations; the anxiety group exhibited greatly elevated levels of sway when standing on foam. Finally, these two-way interactions were modulated by a significant Task × Vision × Group interaction, $F(2, 40) = 6.124$, $p < .001$. As can be seen in Figure 1 the sway area was much larger during the condition where AN participants stood with their eyes closed on the foam surface than during all other conditions. The interaction was explored by performing separate 2 × 2 ANOVA's for each task (BS, FS and DT), with group and vision as factors. As expected, the Group × Vision interaction was only significant for the FS task, $F(1, 20) = 4.310$, $p < .05$, and not for the other tasks. It thus seems to be the case that the three-way interaction was caused by extreme values in one

particular condition, namely the condition where AN children maintained balance under the most challenging circumstances (foam, eyes closed).

Sway velocity

We found main effects of group, $F(1, 20) = 7.601$, $p < .05$, task, $F(2, 40) = 73.063$, $p < .001$, and vision, $F(1, 20) = 69.513$, $p < .001$. The main effect of group indicated that sway had overall greater velocity for the AN group than the TD group. The main effect of task was due to significantly elevated levels of sway velocity in the foam condition, compared to other conditions. Also, removal of vision led to higher sway velocity.

We found two two-way interactions, Task × Vision, $F(2, 40) = 112.230$, $p < .001$, and Task × Group, $F(2, 40) = 3.316$, $p < .05$. The first can be explained by the fact that standing with eyes closed on the foam surface resulted in faster body sway than the other conditions. The second was due to high sway velocity for the anxiety group when standing on foam.

Finally, the three-way Task × Vision × Group interaction was significant $F(2, 40) = 6.191$, $p < .001$. Similar to the findings with the sway area, this was due to rather high sway velocity values in one particular condition, namely the condition where AN children maintained balance under the most challenging circumstances (foam, eyes closed). Mean values across groups and condition are shown in Figure 2.

Normalized sway path length

The main effect of group, $F(1, 20) = 7.549$, $p < .05$, on the normalized sway path length (SPn) showed that the AN group exhibited a significantly overall shorter sway path than the TD group. In other words, the anxiety Group showed less 'twisting and turning' during quiet standing than the control group. The main effect of task, $F(1,20) = 18.715$, $p < .001$, revealed that SPn values were significantly lower in the foam condition than in the other two conditions (BS-DT: $t(21) = 0.474$, $p > .1$; BS-FS: $t(21) = 3.333$, $p < .05$; FS-DT: $t(21) = 3.562$, $p < .05$). Both main effects were modulated by a significant Task × Group interaction, $F(2, 40) = 4.047$, $p < .05$. As can be seen in Figure 3, there was a larger decrease in SPn values for the TD group than for the AN group when standing on foam.

Sample Entropy

Statistical analysis of the SampEn values revealed main effects of group, $F(1, 20) = 9.667$, $p < .05$, task, $F(1, 20) = 16.841$, $p < .001$, and vision, $F(1, 20) = 10.594$, $p < .05$. The sway path of the AN group exhibited lower SampEn values than the control group, indicating greater regularity of the COP time series. The effect of task was due to reduced SampEn values during standing on foam relative to the other two conditions. Finally, removal of vision led to a decrease in SampEn compared to when the eyes were open (Figure 4).

In addition, a significant Task × Group interaction was found, $F(2, 40) = 3.245$, $p < .05$, which can be explained by the fact that there was only a significant difference in SampEn between the groups during the more challenging tasks (FS: $t(21) = 2.445$, $p < .05$, DT: $t(21) = 3.778$, $p < .001$) and not during normal standing (BS; $t(21) = 1.956$, $p > .1$), regardless of whether vision was available. There was also a significant Vision × Group interaction, $F(2, 40) = 4.618$, $p < .05$. Post hoc analyses revealed that the main effect of vision only applied to the TD group: removal of vision induced significantly lower SampEn values for this group, $t(10) = 4.735$, $p < .001$, whereas removal of vision did not lead to a change in regularity for the AN group ($t(10) = 0.673$, $p > .1$).

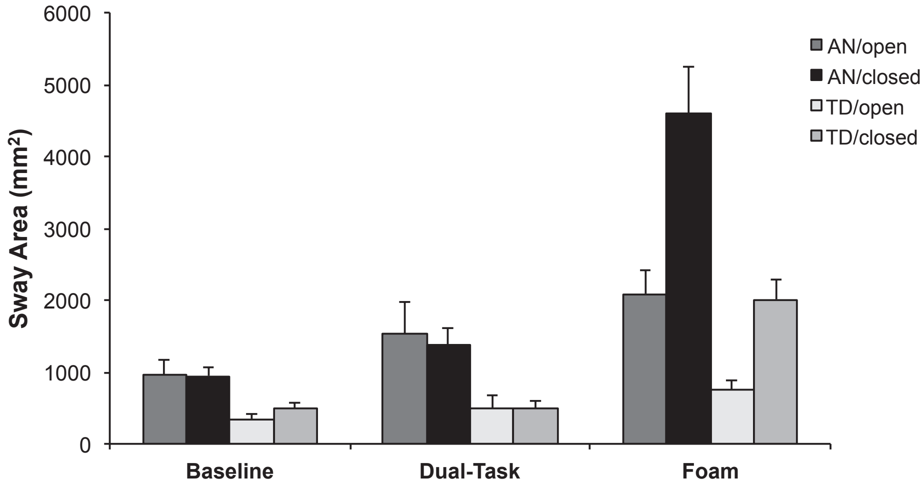

Figure I: Sway area (mean + s.e.m.) as a function of group, vision and task. AN = anxiety group, TD = typical developing group

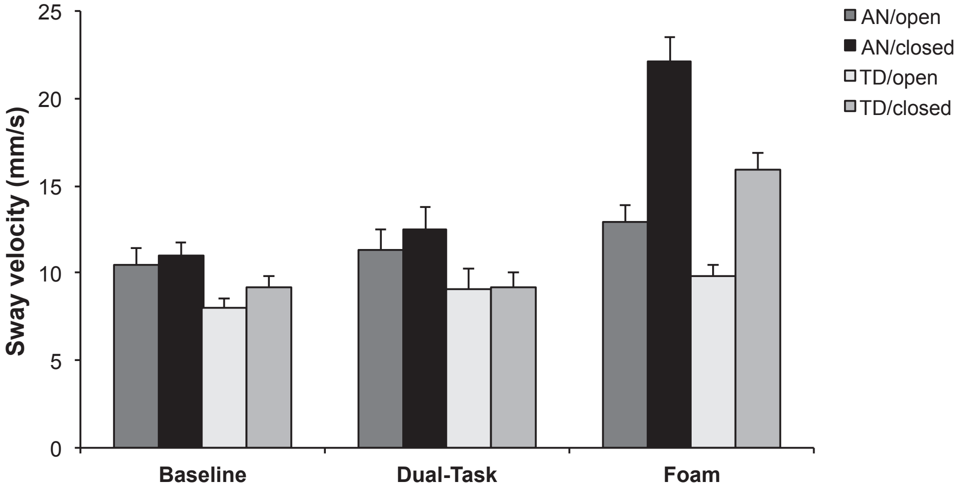

Figure II: Sway velocity (mean + s.e.m.) as a function of group, vision and task. AN = anxiety group, TD = typical developing group .

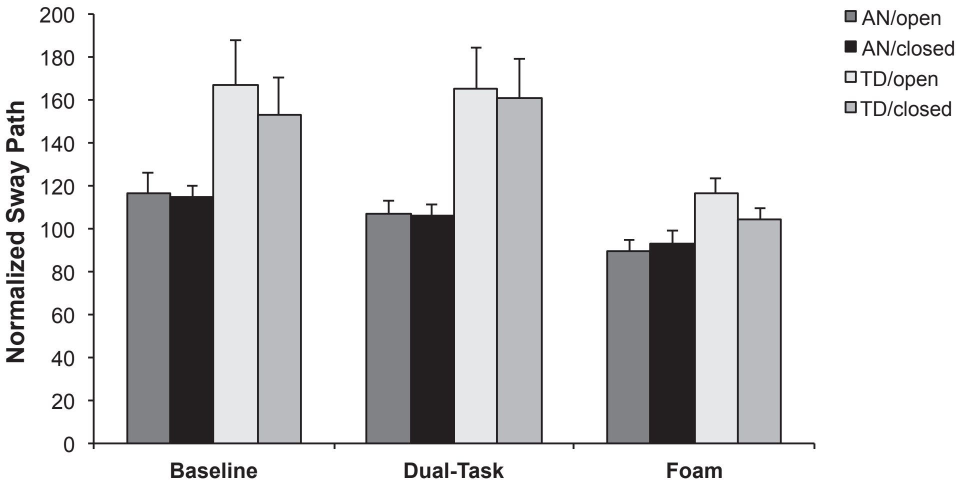

Figure III: Normalized Sway Path length (mean + s.e.m.) as a function of group, vision and task. AN = anxiety group, TD = typical developing group.

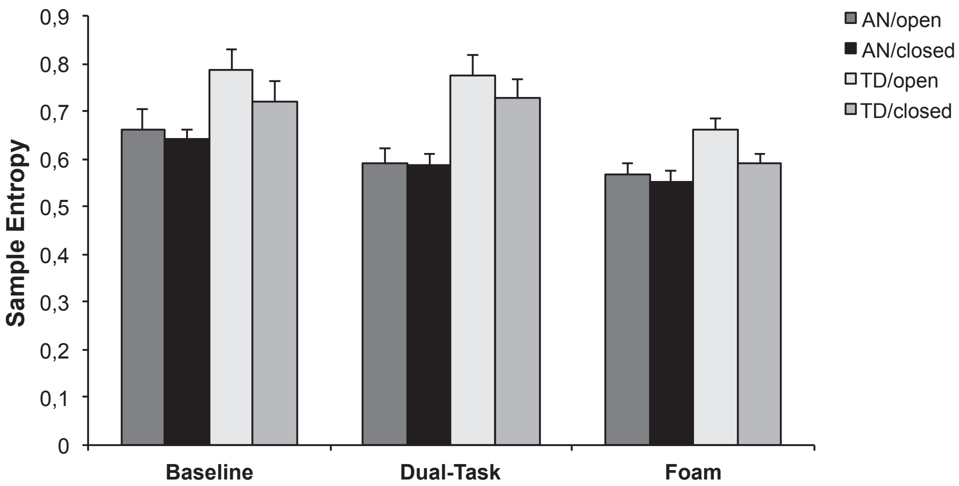

Figure IV: Sample Entropy (mean + s.e.m.) as a function of group, vision and task. AN = anxiety group, TD = typical developing group.

Discussion

The aim of the present study was to gain further insight into the balance-anxiety link, using posturographic measures. We examined the behaviour of the naturally occurring body sway in a group of children with elevated anxiety levels and an age-matched control group, using a variety of sensory and cognitive manipulations. The analyses focused on theoretically motivated measures related to postural stability and the complexity of the COP time series. The main results can be summarized as follows.

First, as hypothesized we found evidence for the presence of sub-clinical postural anomalies in children with elevated levels of anxiety. The COP fluctuations of the anxiety group during normal standing exhibited a larger sway area than the controls. This is suggestive of lower postural stability, although it should be noted that the precise relation between the amount of sway and stability of the human "inverted pendulum" remains to be elucidated (e.g. Frazier and Mitra, 2008). Also, COP movements were relatively fast in the anxiety group. It has been argued that high sway velocity is indicative of greater open-loop regulation of balance (Riach and Starkes, 1994), as opposed to closed-loop (automatized) balance, which could mean that the anxiety group is less reliant on automatized postural control processes. In addition, we found that the COP fluctuations of the anxiety group were on average less complex than those of controls, as exemplified by shorter normalized sway path (suggestive of fewer corrective sub-movements) and greater regularity, which is also in line with our hypothesis. These latter two measures have been linked to the amount of attention invested in the regulation of balance. As argued in the Introduction, postural sway of patients with neurological disorders such as stroke or concussion is characterized by greater regularity, which is suggestive of increased cognitive control to compensate for the reduced capabilities of the motor system to operate in an automatic and fluent fashion. In relation to this, it was found (Roerdink et al., 2006) that regularity of the COP fluctuations of stroke patients decreased again in the course of rehabilitation, which was interpreted as a progressive reduction in attentional investment, i.e., increased automaticity of postural regulation. Another study (Stins, Michielsen, Roerdink, and Beek, 2009) examined the other end of the hypothesized automaticity continuum, and it was found that the COP of young skilled dancers was even less regular than that of healthy controls, suggesting even less cognitive investment in balance, i.e., a more fully automatized form of balance control. Thus, the present findings suggest that children with elevated levels of anxiety utilize excessive attentional resources for the maintenance of posture. Under normal circumstances the regulation of balance takes place in a (nearly) fully automatic manner, which leaves the actor enough room to allocate attention to other tasks, such as talking, thinking, or visual search. Our results imply that children with elevated levels of anxiety will be less capable of dividing attention between the regulation of balance and cognitive secondary tasks. Future studies will have to control for differences in cognitive capability, in order to test this hypothesis more rigorously.

Second, we found that the availability of visual information affected the COP. When standing with eyes closed there was an overall increase in body sway, an increase in sway velocity, and an increase in the regularity of the COP fluctuations, compared to quiet standing with the eyes open. Although it is usually assumed that increase in body sway with eyes closed is due to loss of stability as a result of the removal of a crucial source of information for the regulation of balance, it could also be the case that the increase in sway reflects that actor's attempt to increase the reliability of vestibular and proprioceptive channels. From this perspective, actors can make a conscious effort to compensate for their loss of vision by increasing the amount of self-generated exploratory motor activity, in the service of facilitating or sensitizing alternate sources of information. Although we found no interaction between group and vision on the amount of body sway, this interaction was significant for the regularity of sway. We found that closing the eyes led to more regularity (suggestive of greater attentional involvement in balance regulation), but only for the TD group, which was contrary to our expectations. It could be the case that children in the TD group changed their postural strategy from automatic control (eyes open) to a strategy involving attentional control (eyes closed), whereas the children in the anxiety group used attentional regulation of balance throughout the experiment, that is, regardless of the availability of visual information.

Third, we found that postural sway was hardly affected by the cognitive secondary task (DT). The only reliable finding involving cognition was a decrease in SampEn for the AN group, suggesting that performing a challenging secondary task (word memorization) led to an even greater attentional involvement in balance for the anxiety group, relative to controls. Although effects of cognition on postural fluctuations are commonly found, the literature is actually quite inconsistent, and at present no firm conclusions can be drawn regarding the way concurrent cognitive tasks impact on the regulation of balance (Frazier and Mitra, 2008).

Fourth, we found that balance was strongly affected by standing on a compliant surface. When standing on foam there was an increase in body sway, an increase in sway velocity, a decrease in the length of the normalized sway path, and an increase in the regularity of the COP fluctuations, compared to standing on a rigid surface. Note that standing on foam reduces the reliability of proprioceptive information from the ankles. This, in turn, may again lead to reduced postural stability, and a greater need to invest attentional resources in the maintenance of balance, resulting in lower complexity of the signal. Importantly, the anxiety group reacted strongly to this manipulation, especially with eyes closed. There was a 4- to 5-fold increase in the size of the sway area in the AN group when standing on foam with eyes closed, compared to standing on a steady surface with eyes open (see Figure 1). The results also clearly show that when the balance task became more difficult the differences in postural performance between the subject groups became greater. This is fully in line with the study described earlier (Erez et al. 2004), where it was found that maintaining balance on an unsteady surface (a trampoline) resulted in a disproportionate increase in balance mistakes in the group of children with anxiety disorder, compared to controls.

At present, only very few studies have examined postural behaviour in various psychopathologies. Sub-clinical postural anomalies were found in children with Gilles-de-la-Tourette syndrome (Lemay et al., 2007), adult obsessive-compulsive disorder patients (Kemoun, Carette, Watelain, and Floriat, 2008), and children with ADHD (Buderath et al., 2009). In all these studies it was theorized that neural structures involved in psychopathology and structures involved in balance regulation share a common network. More specifically, some authors (Lemay et al., 2007) speculated that the observed postural anomalies were due to impaired feedback processing, associated with fronto-striatal dysfunction. Along similar lines, others (Kemoun et al., 2008) proposed that prosencephalic structures - involved in anxiety - can influence the vestibular system via the parabrachial nucleus. It has also been suggested that postural dysregulation could be related to mild cerebellar dysfunction (Buderath et al., 2009). At present, it is unknown whether psychopathology can directly dysregulate the neural systems that subserve the regulation of balance, or whether some unknown brain lesion (either hereditary or acquired) simultaneously affects a number of subsystems in the course of brain maturation, which would be consistent with the notion of 'atypical brain development' (e.g. Gilger and Kaplan, 2001). According to this notion, developmental brain disorders can result in a spectrum of seemingly unrelated disabilities, resulting in unique neuropsychological profiles that do not fit nicely in pre-existing diagnostic categories. Comorbidity (or "co-occurrence"; Kaplan, Dewey, Crawford and Wilson, 2001) of neuropsychiatric problems is therefore the rule, not the exception. The studies cited above all reported comorbid disorders in their sample, and they acknowledged that the heterogeneity of the patients groups precludes drawing strong conclusions. With respect to our clinical sample, the children had behaviour problems related to ADHD and OCD, so that our observation of postural anomalies cannot be attributed exclusively to anxiety. Future studies will have to reduce the within group variance by either using more heterogeneous samples (preferably also gender-matched), or through appropriate statistical techniques such as multiple regression. In addition, brain imaging studies can shed valuable light on which brain structures (limbic, motor, or otherwise) are affected.

Limitations
A clear limitation concerns the heterogeneity of the sample in terms of clinical status. Relatedly, possible comorbidity with other disorders puts a limit on the generalizability of the findings. However, the findings are consistent with the emerging view that anxiety disorders and balance performance are intertwined.

Conclusion
We found postural anomalies in children with elevated anxiety levels. The children exhibited overall more regular postural sway even for the simplest balance task which suggests that the underlying postural control is qualitatively different from children without elevated anxiety. We postulated that these anomalies are in part due to an excessive attentional focus (possibly related to hypervigilance) to the own body. The present study is consistent with the increasing awareness in the psychiatric field that neurodevelopmental disorders may benefit from movement and body-oriented treatment approaches.

Chapter 5

Psychiatric symptoms in children with gross motor problems

This chapter has been submitted and is currently under review as:

Emck, C., Bosscher, R.J., van Wieringen, P.C.W., Doreleijers, Th., Beek, P.J. Psychiatric symptoms in children with gross motor problems.

Abstract

Background: Children with psychiatric disorders often demonstrate gross motor problems. This exploratory study aims at investigating if the reverse holds true as well by assessing specific types of psychosocial and psychiatric problems present in children with gross motor problems signalled at school.

Method: Emotional, behavioural and autism spectrum disorders (ASD), as well as psychosocial problems, were assessed in a sample of 40 children who were referred to a movement intervention program and showed qualitative gross motor problems as identified by the Test of Gross Motor Development (TGMD-II). The assessment consisted of a parent interview (Diagnostic Interview Schedule: DISC-P) and parent (Child Behaviour Checklist: CBCL; Children's Social Behaviour Questionnaire, CSBQ) and child questionnaires (Self-Perception Profile for Children, SPCC).

Results: A large proportion of the sample (65%) met the criteria for a psychiatric classification. Anxiety disorders were diagnosed most often (45%), followed by ASD (25%) and attention deficit hyperactivity disorders (15%), all of which were significantly more prevalent than in the general age-matched population. On the CBCL syndrome scales, internalizing problem behaviour and social problems were prominent (51.3% and 41%, respectively). On the CSBQ, 'stereotyped behaviour' as well as 'resistance to changes' was observed in 92.5% of the sample. Self-perceived incompetence was found in 38.5% ('athletic competence') and 17.9% ('social acceptance') of the children. 'Behavioural conduct' and 'scholastic competence' were domains in which almost all children (94.9% and 92.3% respectively) perceived themselves as competent.

Conclusion: A large proportion of children with gross motor problems had significant emotional and behavioural problems that met the criteria for psychiatric classification. The types of problem concerned internalization, anxiety and (symptoms of) ASD, and to a lesser extent externalization. Self-perceived incompetence was restricted to domains that were indeed impaired, i.e. the motor domain and social functioning.

Introduction

Gross motor problems - i.e. problems with the performance of basic skills such as running, jumping and throwing - are abundant in children with psychiatric disorders (Emck, Bosscher, Beek, and Doreleijers, 2009). For instance, poor motor coordination and balance control have been reported for children with dysthymia and anxiety disorders (Erez, Gordon, Sever, Sadeh, and Mintz, 2004; Stins, Ledebt, Emck, Dokkum, and Beek, 2009; Vance et al., 2006), as well as for children with attention deficit hyperactivity disorders (ADHD) (Chen, Tseng, Hu, and Cermak, 2009; Dewey, Cantell, and Crawford, 2007; Gillberg & Kadesjö, 2003; Miyahara, Möbs, and Doll-Tepper, 2001; Pitcher, Piek, and Barrett, 2002; Pitcher, Piek, and & Hay, 2003; Tseng, Henderson, Chow, and Yao, 2004; , Tseng, Howe, Chuang, and Hsieh, 2007; Vance et al., 2006) and pervasive developmental disorders, i.e. autism spectrum disorders (ASD) (Dewey et al., 2007; Emck et al., 2009; Ghaziuddin & Butler, 1998; Green, Charman et al., 2009; Kopp, Beckung, & Gillberg, 2009).

Because psychiatric disorders are often accompanied by gross motor problems, we wondered whether the reverse is also true, i.e. are children with gross motor problems at risk for psychiatric disorders? It is well known that children with gross motor problems are less likely to participate in games and plays requiring skills like jumping, running, or throwing balls, and that they tend to be physically less fit than typically developing children (Cairney et al., 2005b; Cairney et al., 2007; Emck, Bosscher, van Wieringen, Beek, and Doreleijers, 2011; Hands & Larkin, 2006). Moreover, gross motor problems have a negative influence on self-perceptions (Peens, Pienaar, and Nienaber, 2008; Piek, Baynam, and Barrett, 2006; Poulsen, Ziviani, and Cuskelly, 2006; Skinner & Piek, 2001). Much less is known, however, about psychiatric symptoms in children with gross motor problems. Green, Baird, and Sugden (2006) reported that a high proportion of children with developmental coordination disorder (DCD) who were referred to occupational therapy were at risk of psychopathology. However, in this study no distinction was made between gross and fine motor problems, and the measure that was used to detect psychopathological symptoms permitted no formal psychiatric diagnoses. Because children with gross motor problems are often referred to movement interventions, it is important to know more about specific co-occurring psychiatric problems. These problems are seldom taken into account in movement intervention programs, which might reduce their effectiveness in improving the broader health status of the children in question. Hence, we investigated psychosocial and psychiatric problems in children who were referred to a movement intervention program on the basis of observed gross motor problems. Importantly, the referral of the children to the movement program was not based on other diagnoses (either physical or mental) than problems with gross motor performance.

In line with epidemiological psychiatric research (Egger & Angold, 2006) the following three broadly defined categories of child psychiatric disorders – and associated symptoms – were distinguished for the purpose of the current study: emotional disorders (ED) (i.e. depression, dysthymia and anxiety disorders), behavioural disorders (BD) (ADHD, oppositional defiant disorders (ODD), conduct disorders), and autism spectrum disorders (ASD). These categories cover the main child psychiatric disorders.
Firstly, we investigated the prevalence of the three types of psychiatric disorders by using clinical diagnostic tests. Secondly, categorical psychiatric measures were complemented by continuous measures. As has been argued by Ferdinand et al. (2004), continuous measures may reveal (sub)clinical symptoms that go unnoticed when the assessment is based on categorical measures only. Finally, in view of the potential impact of gross motor problems on psychosocial functioning, we also investigated social behaviour and self-perceived competence.
To anticipate, the innovative aspect of the present study concerns a detailed account of psychosocial problems and psychiatric symptoms of children with gross motor problems. This may help to develop more effective interventions for children with gross motor problems.

Method

Data were collected as part of a research project investigating the relationship between psychiatric and gross motor problems in children (See: Emck et al. 2009, 2011). The study approval was granted by the Medical Ethics Committee of VU Medical Center.

Participants and procedure

The data for this exploratory study were collected from children aged 7 through 12 who were referred to a movement intervention program. Children who were deemed to have motor problems were referred by physical education teachers from elementary schools in two regions in the Netherlands. Parents were informed about the research project through a letter, e-

mail and oral information by research assistants. After they agreed to participate, parents received an informed consent and questionnaires. At the start, general information about the child and its family, medical status and history of cognitive and motor development was obtained in a semi-structured interview of the parent, and a questionnaire was completed by the child (Self-Perception Profile for Children, SPCC). The next week, gross motor skills of the children were assessed by means of the Test of Gross Motor Development (TGMD-II) and psychiatric symptoms and psychosocial problems were assessed by means of a parent interview (Diagnostic Interview Schedule – parent version: DISC-P) and parent questionnaire (Child Behaviour Checklist: CBCL; Children's Social Behaviour Questionnaire, CSBQ) (see: Measures). All tests were conducted by two human movement scientists.
Of the available 108 children, 80 (74%) were willing to participate. Reasons for non-participation were always related to lack of time by the parents or other organisational problems at home. Next, 36 children were excluded because they visited a child psychologist or child psychiatrist for treatment, had a mild mental retardation, or used medication that influenced psychomotor Performance. An additional four children were excluded because no qualitative impairments in basic gross motor skills could be identified by means of the TMGD-II (see: Measures). This resulted in a final sample of 40 children (32 boys, 8 girls, mean age 10y 0mo, SD 1y 3mo). Boys and girls did not significantly differ in age ($t = .29$, $p = .77$).

Measures

Test of Gross Motor Development (TGMD-II) (Ulrich and Sanford, 2000). The TGMD-II was developed to evaluate gross motor skills associated with everyday games and sports in children aged 3-10 years. The subtests of the TGMD-II, locomotion and object control, each consist of six separate skills. Locomotion skills are: run, gallop, hop, leap, horizontal jump, and slide; object control skills are: striking a stationary ball, stationary dribble, catch, kick, overhand throw, and underhand roll. Qualitative age- and gender-dependent criteria for the skill patterns are available for each skill, as well as directives for (quantitative) scoring the degree to which an observed pattern matches the ideal pattern. A higher score indicates a better quality of the movement pattern. Raw scores for locomotion and object control are converted to standard scores for each of these subtests (mean 10, sd 3), and to a Gross Motor Quotient (GMQ, mean 100, sd 15) for overall gross motor ability. A GMQ below 90, or standard scores on locomotion or object control below

8 might indicate a gross motor problem (Bonifaci, 2004; Ulrich and Sandford, 2000). Adequate reliability and validity have been reported for use in typically developing children (Evaggelinou, Tsigilis, and Papa, 2002; Ulrich and Sandford, 2000), children with intellectual disabilities (Simons et al., 2008), and 6-12 year-old children with visual impairments (Houwen, Hartman, Jonker, and & Visscher, 2010). In the present research, ICC's between two observers varied from .86-1.00. Although the TGMD-II was originally developed for 3- to 10-year old children, recent studies have employed the TGMD-II for children up to 12 years (Houwen et al., 2010; Hartman, Houwen, Scherder, and Visscher, 2010). We used the norms of 9- and 10-year old children for the children who were aged 11 and 12 because no significant differences in GMQ, locomotion or object control have been found for these age ranges (Emck et al., 2011).

Diagnostic Interview Schedule for Children – parent version (DISC-P) (Costello, Edelbrock, Dulcan, Kalas, and Klaric, 1984; Dutch version: Ferdinand and Van der Ende, 2002). The DISC-P is a highly structured parent interview, aimed at screening general and clinical populations for child psychiatric disorders, except ASD (Cox, 1994). Algorithms are provided to decide whether a disorder is present or absent, providing a dichotomous outcome measure. The reliability and validity of the DISC-P are adequate for the population of (Dutch) children aged 6- to 18 years (Costello et al., 1984; Ferdinand et al., 2002; Shaffer, Fisher, Lucas, Dulcan, and Schwab-Stone, 2000).

Children's Social Behaviour Questionnaire (CSBQ) (Luteijn, Minderaa, and Jackson, 2002). The CSBQ is a questionnaire for parents, with six subscales to identify specific symptom patterns of ASD. Four of the six subscales refer to the core areas of deficit in ASD (Hartman et al., 2006; Lord & Rutter, 1994). These (primary) subscales are: 1. 'reduced social contact and social interest', 2. 'difficulties in understanding social information', 3. 'stereotyped behaviour', 4. 'fear of and resistance to changes'. Two additional subscales cover 'not optimally tuned to the social situation' and 'orientation problems in time, place, or activity'. Scores range from 1 (very low) to 7 (very high); higher scores indicate more problematic behaviour. For each subscale norms are provided for children with PDD-NOS, ADHD and mental retardation, as well as for the general child psychiatric population. The reliability and the validity of the CBSQ and its subscales are satisfactory (Hartman, Luteijn, Serra, and Minderaa, 2006). In line with an earlier study

(Emck et al., 2011), children who scored in or above the average category for the PDD-NOS norm group on three of the four primary subscales were classified as ASD**.**

Child Behaviour Checklist (CBCL, Achenbach and Rescorla, 2001; Dutch version: Verhulst, van der Ende, and Koot, 1997). The CBCL is a commonly used instrument with multiple dimensions that assesses emotional and behavioural problems in children aged 4 to 12 years by asking parents to indicate which of 113 behaviours is shown by their child. We used the broad band scales 'Internalizing', consisting of the narrow band scales 'anxious/depressed', 'withdrawn/depressed' and 'somatic complaints', and 'Externalizing', consisting of the narrow band scales 'rule breaking behaviour' and 'aggressive behaviour'. In addition, the narrow band scales 'social problems', 'thought problems', and 'attention problems' were used. Scores on the syndrome scales are converted to T-scores and classified as falling in the normal, borderline or clinical range. According to the manual, scores in the borderline range are considered high enough to be of concern (Achenbach and Rescorla, 2001). The test-retest reliability and the internal consistency of the scales are satisfactory (Achenbach and Rescorla, 2001; Evers, van Vliet-Mulder & Groot, 2000).

Self-Perception Profile for Children (SPPC; Harter, 1985; Dutch version: Veerman, Straathof, Treffers, van der Bergh, and ten Brink, 1997). The SPPC is a 36-item scale that measures perceived competence in children, and is appropriate for use during middle childhood. The scale consists of six subscales: 'scholastic competence' reflects the child's perception of his/her school-related competence; 'social acceptance' reflects the child's feeling of acceptance by peers, 'athletic competence' reflects the feeling of competence about sport and outdoor activities, 'physical appearance' reflects the child's feeling of satisfaction with his/her looks, 'behavioural conduct' reflects the child's feeling of satisfaction with his/her behaviour, and 'global self-worth' reflects the child's feeling of satisfaction with one's own person, the life he/she lives and his/her self-confidence. Items are scored on 4-point rating scales with higher scores indicating greater self-perceived competence. The 15th and 85th percentile are used as cut-off points defining low and high self-perceived competence, and established for boys and girls separately. Adequate internal consistency and validity have been reported (Evers, van Vliet-Mulder & Groot, 2000; Harter, 1985; Veerman et al., 1997).

Statistical analyses

Descriptive statistics with regard to the administered tests included the following variables:

DISC-P: Numbers and percentages of children meeting the criteria for psychiatric classification. CSBQ: Median scores and interquartile ranges, as well as the numbers and percentages of children with scores in the clinical range on each of the subscales and on the total score.

CBCL: Means and standard deviations of the scores, as well as the numbers and percentages of children with scores in the borderline and clinical range for both the broad and small band syndrome scores.

SPCC: Median scores and interquartile ranges, as well as the numbers and percentages of children with scores in either the upper or lower 15% of the scores in the norm group. The percentages of children who were classified with specific psychiatric disorders were compared to the correspondent percentages in the age-matched Dutch population (Verhulst, 2008) by means of binomial tests. The same test was used to compare the number of children that were classified with at least one psychiatric disorder with the corresponding percentage of children in the age-matched Dutch population as published by Zwirs et al. (2007).

Results

Mean GMQ was 80.27 (sd 12.93); mean standard scores were 7.68 (sd 2.60) for locomotion and 5.82 (sd 2.36) for object control, respectively. Table 1 shows the number and percentages of children with a psychiatric classification, based on the DISC-P and the CSBQ. Classifications were not exclusive, i.e. one child could have more than one classification. Emotional disorders always concerned anxiety; no children in our sample met the criteria for depression or dysthymia. Behavioural disorders always concerned ADHD, in one case with comorbid ODD. Other disorders were tics, enuresis and encopresis, each of which were observed in two children.

Table 1. Children (numbers and percentages) with a psychiatric classification, based on the DISC-P and the CSBQ

	No classification	One or more classifications	Emotional disorder	Behavioural disorder	ASD	Other disorder
Boys (n = 32)	14 (43,8%)	18 (56,3%)	13 (40,6%)	5 (15,6%)	7 (21,8%)	5 (15,6%)
Girls (n = 8)	0 (0%)	8 (100%)	5 (62,5%)	1 (12,5%)	3 (37,5%)	1 (12,5%)
Total (n = 40)	14 (35%)	26 (65%)	18 (45%)	6 (15%)	10 (25%)	6 (15%)

DISC-P = Diagnostic Interview Schedule for Children, parent version; CSBQ = Children's Social Behaviour Questionnaire; ASD = autism spectrum disorders. Classifications are not mutually exclusive

Compared to the prevalence in the general child population, the research sample comprised a significantly higher percentage (65% vs 8-14%, p < .001) of children meeting the criterion for at least one psychiatric classification. Compared to prevalences of *specific* psychiatric disorders in the Dutch general child population, the research group showed significantly higher percentages (anxiety 45% vs 3%, p < .001; ADHD 15% vs 4%, p = .005; ASD 25% vs 1% , p < .001).

Table 2a and b show mean scores and standard deviations of clinical syndromes according to the parents (CBCL), as well as the numbers and percentages of children scoring in the borderline and clinical range. Internalizing problem behaviour was reported more often than externalizing problem behaviour. On the small band syndrome scales, social problems were reported most frequently, followed by withdrawn/depressed and anxious/depressed problem behaviour.

Median scores on CSBQ subscales fell in the average (score 3) or above average (score 4) category of the general child psychiatry norm group, indicating serious social problems. The most prevalent problems were 'resistance to changes' and 'stereotyped behaviour', two of the four subscales that refer to core symptoms of ASD. On these subscales, very high proportions of children scored in the clinical range (Table 3).

Table 2a. Means and standard deviations of T-scores on CBCL broad band syndrome scales and number and percentages of children who score in the borderline or clinical range

CBCL (n = 39)*	Total	Internalizing	Externalizing
Mean	54.7	57.7	49.0
SD	11.3	9.4	11.3
Range	31-73	39-74	33-71
Borderline range	5 (12,8%)	8 (20,5%)	4 (10,3%)
Clinical range	9 (23,1%)	12 (30,7%)	3 (7,7%)
Total	14 (35,9%)	20 (51,3%)	7 (17,9%)

*CBCL = Child Behaviour Checklist. CBCL cutoff- points of the broad band syndrome scales: Normal range T ≤ 59, borderline range 60 ≤ T ≤ 63, clinical range T ≥ 64. Total: number and percentage of children with scores high enough to be of concern from a clinical perspective. * One questionnaire was not returned by the parents*

Median percentile scores on SPPC subscales, and the number and percentage of children who scored below the 15th or above the 85th percentile are shown in Table 4. 'Behavioural conduct' was the domain in which the children perceived themselves as most competent, followed by 'scholastic competence'. Perceived competence in the athletic and social domains was relatively low.

Discussion

In this exploratory study, we investigated emotional and behavioural problems in a sample of elementary school-aged children who were referred to a movement intervention program because of gross motor problems. We focussed on psychiatric disorders and syndromes, social functioning and self-perceived competence, using parent and self-reports.

Our sample was confined to gross motor problems as confirmed by low scores on the TGMD-II (Ulrich and Stanford, 2000). The final sample was characterized by impairments in both locomotion and object control skills. A high percentage of the children in the sample (65%) met the criteria for at least one psychiatric classification and had significant social impairments. Indications for each of the three main groups of psychiatric disorders, i.e. emotional, behavioural and autism spectrum disorders will be discussed below in that order.

Table 2b. Means and standard deviations of T-scores on CBCL small band syndrome scales and number and percentages of children who score in the borderline or clinical range

CBCL (n = 39)*	Anxious depressed	Withdrawn depressed	Somatic complaints	Social problems	Thought problems	Attention problems	Rule breaking behaviour	Aggressive Behaviour
Mean	58.3	59.6	55.3	61.5	57.9	57.6	52.4	54.7
SD	8.4	7.3	5.9	9.0	8.6	10.8	4.2	6.1
Range	50-78	50-72	50-70	50-83	50-80	50-100	50-68	50-69
Borderline range	4 (10,3%)	8 (20,5%)	2 (5,2%)	10 (25,6%)	1 (2,6%)	1 (2,6%)	1 (2,6%)	6 (15,4%)
Clinical range	5 (12,8%)	6 (15,4%)	1 (2,6%)	6 (15,4%)	5 (12,8%)	5 (13,8%)	0	0
Total	9 (23,1%)	14 (35,9%)	3 (7,7%)	16 (41%)	6 (15,3%)	6 (15,3%)	1 (2,6%)	6 (15,3%)

*CBCL = Child Behaviour Checklist. CBCL small band syndrome scales cutoff-points are higher (i.e. more conservative) than on the broad band syndrome scales: Normal range $T \leq 64$, borderline range $65 \leq T \leq 69$, clinical range $T \geq 70$. * One questionnaire was not returned by the parents*

Table 3. Median categorical scores and interquartile ranges on the CSBQ and subscales, and number and percentages of children who score in the clinical range

CSBQ (n = 40)		CSBQ subscales					
	CSBQ total	Poor social tuning	Reduced social interest	Orientation problems	Misunderstanding social information	Stereotyped behaviour	Resistance to change
Median	3	3	3	3	3	4	4
Interquartile range	3	3	2	2	2	0	1
Clinical range	12 (30%)	12 (30%)	19 (47,5%)	13 (32,5%)	18 (45%)	37 (92,5%)	37 (92,5%)

CSBQ = Children's Social Behaviour Questionnaire

Table 4. Median categorical scores and interquartile ranges on the SPPC, and number and percentages of children with scores in the upper and lower 15% of the norm group.

SPPC (n = 39)*	Scholastic competence	Social acceptance	Athletic competence	Physical appearance	Behavioural conduct	Global Self-worth
Median	57.5	29.0	22.0	40.0	78.0	57.0
Interquartile range	55	60	35	48	43	59
Low	3 (7,7%)	7 (17,9%)	15 (38,5%)	5 (12,8%)	2 (5,1%)	3 (7.7%)
High	11 (28,2)	3 (7,7%)	1 (2.6%)	5 (12,8%)	15 (38.5%)	5 (12,8%)

*SPPC = Self-Perception Profile for Children; Low = below 15th percentile of normgroup; High =above 85th percentile of normgroup. * One questionnaire was not completed by the child.*

Emotional disorders diagnosed by means of the DISC-P were manifest in 45% of the children. In each case this pertained to anxiety disorders, a finding that gains in importance in view of the observation of Sigurdsson, van Os, and Forbonne (2002) that the experience of anxiety in motor-impaired boys may persist into adolescence. Although depressive or dysthymic disorders were not present in our sample, subclinical mood symptoms were observed with the (continuous measure) CBCL. On this checklist, parents reported internalizing problems for 50% of the children, in particular with regard to anxious-depressed and withdrawn-depressed behaviours. Thus, several mood symptoms may be present without being organised in patterns that qualify for the categorical diagnosis of depression (see also Cartwright-Hatton, McNicol, and Doubleday, 2006).

The co-occurrence of gross motor impairment and anxiety disorders may be tentatively explained by a common neurophysiological mechanism. It has been suggested that a dysfunction of the parabrachial nucleus, where neural circuits involved in balance control and anxiety interact, may result in balance problems, poor postural control and anxiety (Balaban & Thayer, 2001; Erez et al., 2004; Stins et al., 2009). Since balance and postural control play a major role in gross motor skills, a relation between these skills and anxiety might be expected. A twin study in a general population sample showed that genetic influences can explain the covariation in clumsiness and anxiety (Moruzzi et al., 2010). However, findings of the twin study of Pearsall-Jones, Piek, Rigoli, Martin, and Levy (2011) support the argument that anxious symptomatology in children can also be caused by environmental influences which are related to motor disorders.

Behavioural disorders, comprising the second main group of disorders, were found in 15% of the children. They all concerned ADHD, which concurs with studies that reported a high co-occurence of DCD and ADHD (Chen et al., 2009; Dewey et al., 2007; Miyahara et al., 2001; Pitcher et al., 2002, 2003; Tseng et al., 2004, 2007) and is in concert with the aforementioned suggestion of shared genetic factors underlying motor and ADHD problems (Martin et al*.,* 2006; Moruzzi et al*.,* 2010). However, ADHD was less prevalent in our sample than either emotional or autism spectrum disorders, which were found in 45% and 25% of the children, respectively. Moreover, as indicated by the continuous scores on the CBCL, externalizing behaviours (rule breaking behaviour and aggressive behaviour) and attention problems were reported less often than internalizing behaviours. Importantly, our sample was selected on the basis of *gross* motor impairment, whereas in samples of other studies fine motor problems were also involved (see Chen et al. 2009; Dewey, Kaplan, Crawford, and Wilson, 2002; Fliers et al., 2009; Green et al. 2006*).* Moreover, according to Fliers et al. (2009), attention deficits may be predominantly associated with fine motor problems and less with gross motor problems.
We found almost no evidence of disruptive behavioural disorders; only one child met the criteria for ODD in combination with ADHD. Furthermore, although some children scored in the borderline range, none of the children scored in the clinical range of rule breaking behaviour or aggressive behaviour on the CBCL.

The third main group of disorders concerned ASD. In 23% of the children the criteria for this disorder were met. To our knowledge, no other studies to date have addressed the prevalence of ASD in children with motor problems, and therefore we cannot compare our findings. However, our data showed marked impairments in social functioning, supporting earlier findings (Cummins, Piek, and Dyck, 2005). We found the highest mean score on the CBCL subscale social problems: scores on this subscale indicated that 40% of the children fell in the borderline or clinical range of this domain. More detailed information of the types of social problems could be derived from the scores on the CSBQ. No less than 93% of our research sample scored in the clinical range on 'stereo-

typed behaviour' as well as on 'fear of and resistance to changes', which are considered core deficits in ASD. Also, 48% showed significant problems concerning reduced contact and social interest and 45% experienced difficulties in understanding social information, two other core deficits in ASD. In short, the *types* of social problems in our sample matched those of children with ASD, even though they did not always meet the diagnostic criteria to be classified as such. This finding concurs with the observation by Cummins et al. (2005) that children with poor motor coordination have specific deficits in empathy, i.e. that they are less competent in recognizing emotions, an aspect of social cognition that is also impaired in children with ASD.
Since it has been suggested that an abnormal development of brain connectivity may underlie problems in integrating functions and social behaviour in ASD (Baron-Cohen & Belmonte, 2005; Belmonte, Allen, Beckel-Mitchener, Boulanger, Carper, and Webb, 2004; Kleinhans et al., 2008), it might also be involved in the co-occurrence of motor problems and social problems encountered in our sample. A special role in this regard may be played by the circuitry including the cerebellum, which qualifies as a common neurobiological link between motor problems and ASD (Allen, Müller, and Courchene, 2004); Belmonte et al., 2004; Piek and Dyck, 2004).

Self-perceived competence was not impaired across the board. In agreement with Ekornäs, Lundervold, Tjus, and Heimann (2010), our sample scored rather low on self-perceived athletic competence and social acceptance, but global self-worth was not affected. Furthermore, the children reported to feel quite competent with respect to scholastic performance and behavioural conduct. It therefore seems that the children in our sample were realistic about their competences, given that their gross motor skills were indeed impaired, which may have hampered them in social games. However, it should be recognized that referral to a movement intervention program, may well have influenced the self-perception in the motor domain.

Limitations of our study include first of all that it was performed on a relatively small convenience sample of children, which militates against generalizing the results to the population of gross motor-impaired children. Secondly, the relatively small sample size precluded separate analyses for boys and girls. Since for most variables gender-specific scores have been used, analyzing the scores of both sexes as belonging to one group seems warranted. However, the fact that all girls in the sample met the criteria for psychiatric classification, relative to 56% of the boys, might be due to referral bias because worries regarding gross motor performance seem greater for boys than for girls (see Cairney, Hay, Faught, Mandigo, and Flouris, 2005a; Cairney, Hay, Veldhuizen, Missiuna, and Faught, 2010). Thirdly, because some children had already started with the movement intervention program, both their motor skills and psychiatric status might have been affected by their participation in the program. However, even if such an effect was present, it should have improved their scores on the variables measured during the assessment, reinforcing our conclusions instead of weakening them. Finally, the cross-sectional design of our study does not permit making any causal inferences. We therefore refrain from giving such explanations other than by tentatively suggesting a common neurophysiological basis for motor problems and some emotional and behavioural problems. Of course, this tentative neurophysiological account for the co-occurrence of these problems does not preclude social explanations, for example: gross motor problems may hamper participation in play and games and therefore affect the social and psychological development (Cairney et al., 2010).

Considering that the children in our sample often showed significant psychosocial and psychiatric problems, we agree with Peens et al. (2008) that interventions for gross motor-impaired children should not only focus on the motor problems, but also on psychosocial impairments. Because participation in movement activities will become more difficult for these children as they grow older, interventions addressing both physical and psychosocial problems should start at an early age (Cummins et al., 2005; Wall, 2004). As stated by Kopp et al. (2009), the combination of motor impairments and emotional, behavioural or autism spectrum disorders compromises daily living, and high quality prevention and intervention are needed. We therefore suggest that, contrary to common practice, children who are referred to movement interventions should be screened for emotional and behavioural problems, which, if present, should be taken into account in adapting the interventions to the specific needs of the children.

Chapter 6

6

PsyMot: an instrument for psychomotor diagnosis and indications for psychomotor therapy in child psychiatry

This chapter has been published as:

Emck, C. and Bosscher, R.J. (2010). The PsyMot: an instrument for psychomotor diagnosis and indications for treatment. *Body, Movement and Dance in Psychotherapy, 1-13 iFirst*

Abstract

Psychomotor therapy is a movement-oriented and body-oriented therapy which resembles dance movement psychotherapy, although some differences remain. Despite historical differences, theoretical backgrounds as well as practical methods of both therapies converge at large. Both fields are in need of assessment development to support diagnosis and treatment. In this article, we present a recently developed systematic tool for psychomotor assessment and diagnosis of children, the PsyMot. The construction of this instrument was inspired by the International Classification of Functioning, children's version, of the World Health Organization. The PsyMot consists of an assessment procedure, guidelines for scoring items and a computer program for converting item scores into scores for clusters of treatment goals. Initial studies suggest that the PsyMot has adequate psychometric qualities, but further research is needed. Possibilities for the use of the PsyMot in different groups are currently being explored.

Introduction

Psychomotor therapy (PMT) for children, as it was developed in the Netherlands, has much in common with dance movement (psycho) therapy (DMT) as practised in the UK and US. Both make use of movement and body experiences to stimulate psychosocial development, decrease psychological and behavioural disturbances, relieve psychiatric symptoms or diminish the impact of these symptoms on the functioning and participation of a particular child in daily life (Berrol, 2006; Emck and Bosscher, 2004; Hammink, 2003; Levy, 1988; Loman, 1998; Petzold, 1996). Recently, Röhricht (2009) described dance movement psychotherapy and psychomotor therapy (i.e. psychomotricity) as both belonging to the heterogeneous field of body-oriented psychotherapy (BOP) with 'the unity of body and mind' as an important common conceptual ground. Other shared theoretical concepts refer to developmental psychology, the embodied mind theory, phenomenological and neuroscientific approaches to body experience and movement behaviour.
Furthermore, both PMT and DMT make use of the exploration of movement characteristics and body experiences of the client in order to optimise the therapeutic process (see e.g. Cruz and Berrol, 2004; Payne, 2006b; Vermeer, Bosscher, and Broadhead, 1997).

Differences between PMT and DMT are predominantly historical in nature. In the UK, practitioners educated as professional dancers and dance teachers introduced body-oriented and movement-oriented therapies in mental health institutions (Levy, 1988; Payne, 2006a). In the Netherlands, physical education teachers were the first to offer movement and exercise programmes to psychiatric patients, emphasising the importance of body experiences (Vermeer et al., 1997). Although both DMT and PMT strongly rely on movement observation in the diagnostic process, their specific methods reflect these historical differences. For instance, DMT uses, amongst others, Laban and Kestenberg Movement Analysis to interpret movement behaviour (Koch, Cruz, and Goodill, 2001; Laban, 1928, 1960; Loman and Merman, 1996). In PMT, more or less standardised movement activities which are based on basic categories of human movement, such as walking, running, throwing and catching, jumping and balancing, are used to evaluate performance in qualitative and quantitative terms. Furthermore, movement-related and sports-related individual or group activities are used to observe behavioural characteristics which may or may not be typical for disorders in the field of child psychiatry.

Besides movement activities stemming from physical education practice, exercises aimed at relaxation, expression, creativity, and body awareness (Brooks, 1974; Dijkstra, 2009; Feldenkrais, 1990; Gendlin, 1981; Pesso, 1973, 1988) have also been integrated into PMT for children (see e.g. Petzold and Metzmacher, 1997). Interestingly, comparable activities have been mentioned for DMT with children. Besides formalised dance, improvisation, (ball) games, play, developmental movement and a variety of props are also used (Bannerman-Haig, 2006; Erfer, 2006). Thus, although DMT and PMT have roots in different fields of practice it seems their methods clearly overlap.

Basic in psychomotricity is that bodily play is relevant for children, and that movement represents meaningful behaviour that is deeply rooted in human nature. As Sheets-Johnstone (2003, p. 413) states: ' . . . play is a complex kinetic phenomenon demanding close attention in its own right as the developmental, evolutionary and the experientially meaningful phenomenon that it is'. For instance, from an evolutionary point of view, pleasure and movement have been described as closely interlinked; locomotor rotational play, like running, leaping, rolling and cavorting, is clearly fun for human and non-human youngsters. Additionally, from a developmental point of view, rough and tumble play enables us to learn (about) our bodies and the bodies of others; we become kinaesthetically attuned to each other (Sheets-Johnstone, 2003). Taken together, movement and bodily experiences are important issues for developing children and thereby worth investigating when (neuro) developmental problems occur. Moreover, it is not surprising that motor problems in children often go hand in hand with emotional, behavioural and pervasive developmental problems, indicating a neurobehavioural link between psychopathology and movement behaviour (Emck, Bosscher, Beek, and Doreleijers, 2009; Stins, Ledebt, Emck, van Dokkum, and Beek, 2009).

In the Netherlands, children are referred to psychiatric centres by a general practitioner in case of serious emotional or behavioural problems. Subsequently, a diagnostic team, often including a psychomotor therapist, assesses diverse aspects of adaptive and maladaptive functioning and formulates a treatment plan. While psychiatric and (neuro)psychological assessment is rather standardised, the procedure of psychomotor assessment has varied to date. However, evidence-based practice is increasingly required, which stresses the importance of theory-based assessment instruments, much in the same way as mentioned for DMT by Cruz and Berrol (2004). In this article we present a recently developed tool for psychomotor assessment and diagnosis that is currently being implemented in clinical practice in the Netherlands. Although research on validity and reliability is still ongoing, we deem it interesting to share our work with colleagues in a field that is close to psychomotricity. We will therefore describe the instrument and illustrate its use in two children, for this purpose named Joan and Dennis. Since our main goal is to introduce the instrument, no full details and comments on the cases are presented.

Joan is an 11-year-old girl, intellectually highly gifted, who fails to mingle with peers. She has no friends and does not participate in games or play. Both her parents and teacher are concerned about her social-emotional development and consult an out-patient child psychiatric centre. The question has been raised whether she suffers from an emotional disorder (anxiety, depression) or a pervasive developmental disorder (Asperger) (DSM-IV; American Psychiatric Association,1994).

Dennis is an 8-year-old boy with learning difficulties. Both at home and at school he is hyperactive and oppositional. He quickly starts a fight with other children and hits his mother when he has a tantrum. His single mother is unable to control him so psychiatric day treatment was indicated. Dennis may suffer from ADHD or ODD (DSM-IV), while a negative self-image and impaired coping behaviour may be contributing factors to his behaviour.

The development of the PsyMot

The PsyMot is a diagnostic tool in which the therapist makes use of two sources of information: (a) psychomotor behaviour observation and (b) self-reported subjective movement and body experiences (Emck, Hammink, and Bosscher, 2007). Thereby, we aim to combine the strength of two psychological assessment methods, i.e. the interview as an individualised procedure that enables us to collect personal and subjective information about the child, and the test as a sample of the child's behaviour under controlled conditions (Cruz and Berrol, 2004; Walsh and Betz, 1990).

In line with earlier work of Hammink (2003), the International Classification of Functioning (children's version) of the World Health Organization (ICF) (www3.who.int/icf) was chosen as the umbrella framework for the construction of the PsyMot. In clinical settings, the ICF is used for functional status assessment, goal setting, treatment planning and monitoring, as well as for outcome measurement. The ICF distinguishes four domains related to health and health behaviour:

(1) Body functions: physiological functions of body systems, including psychological functions;
(2) Activities and participation: the execution of a task or action by an individual and involvement in a life situation;
(3) Environmental factors: physical, social and attitudinal environment in which people live and conduct their lives;
(4) Personal factors: individual characteristics such as gender, race, education and developmental level (www3.who.int/icf).

Each ICF domain is operationalised in subdomains that include specific aspects. For instance, the domain body functions includes the subdomains mental functions and sensory functions and the domain activities and participation includes subdomains such as mobility and communication. For the construction of the PsyMot, we followed the procedure as described by Walsh and Betz (1990). We selected ICF subdomains relevant to psychomotor diagnoses and therapy; next, we selected aspects within these subdomains to create an item pool. Each item was carefully defined on the basis of the official ICF definition and additional information from several handbooks of developmental psychology and child psychiatry (Cicchetti and Cohen, 2006; Cole and Cole, 2004; Rutter, Taylor, and Hersov, 2004). The items were administered to a sample of children with psychiatric disorders, after which item analysis was carried out with the help of an expert panel. This resulted in several adjustments. Finally, the complete PsyMot was administered by several therapists to children who were referred to psychomotor therapists, which led to slight adaptations of the procedure.

The item list

The final item list of the PsyMot is shown in Table 1. Space limitation prevents inclusion of all definitions but two examples may be illustrative:

> <u>Exploration</u> (item 3): 'the disposition to act in an initiating manner, moving towards persons or things rather than retreating or withdrawing.' In psychomotor therapy this item is evaluated by observing the way a child (actively) explores the therapy room and its materials by moving towards objects, and by touching, testing and trying them.

Joan hesitates when she is asked to explore the room. After several encouraging interventions, she walks around, touching some materials, while she is continuously looking at the therapist to seek approval.

Body awareness (item 13): 'specific mental function related to the representation and awareness of one's body. It also includes awareness of body boundaries, the position of limbs and bodily sensations.' In psychomotor therapy, we focus on the subjective experience of the body; body awareness concerns feeling, recognising and differentiating bodily sensations in relation to emotions and feelings. For instance: Does the child have an idea where his or her arms and legs are located – and elbows, knees, heart, lungs? Is the child able to describe bodily sensations, like heart beating, or feeling warm? Are there any negative bodily sensations, such as having pain, being tired, feeling stiff, tense, heavy, weak, cold, or warm? What about feelings of dissociation? Does the child experience his or her body as belonging and pleasurable?

During the exercise, Dennis can name a few body parts. The therapist then helps him to focus on his legs. He experiences strange sensations that frighten him and he becomes agitated.

Clusters of treatment goals

In addition to the item list, the PsyMot contains seven clusters of treatment goals for which a child may be classified on the basis of item scores. These clusters, derived from qualitative research by Hammink (2003), are not mutually exclusive, but present the main topics in psychomotor therapy for children. They include body acceptance, participation and enjoyment in movement activities, self-perceived physical and motor competence, motor performance, self-control, self-confidence and self-expression, and playing and interacting with peers. Here, we will not elaborate on the various theoretical concepts that may be related to these clusters, but instead, we provide a short description of each cluster.

A. Body acceptance

Therapy in this cluster aims to develop a positive body experience, improve awareness of and contact with one's own body, and reduce psychosomatic tendencies. A main focus is to become aware of bodily feelings and sensations. In some cases, a child's negative experiences may have hampered the development of body awareness. In other cases, the child may misinterpret body signals or show impaired conscious awareness of bodily feelings and sensations. Goals such as attending to bodily sensations, perceiving and becoming aware of bodily feelings, and finally accepting and interpreting bodily sensations all belong to this cluster.

B. Participation and enjoyment

Therapy in this cluster is focussed on participating in movement activities, reducing fear and anxiety, and stimulating feelings of safety and relaxation. The aim is to break the chain of avoidance behaviour and fear of movement games and play in order to offer children the possibility of acquiring positive body and movement experiences. In conjunction with reducing bodily tension and promoting enjoyment of movement activities, this supports the development of adequately and positively perceived motor competence (see cluster C).

C. Perceived physical and motor competence

This cluster helps children to obtain knowledge of their physical and motor competence, by experiencing and exercising a broad range of movement activities, exercises, games and play. Treatment goals focus on developing an adequate idea of one's movement skills and abilities in order to develop an adequate body-image and self-image. Negative expectations as well as a positive illusionary bias may be the focus of attention in this cluster.

D. Motor performance

Therapy in this cluster aims to improve gross motor skills (locomotion and object control), to enhance spatial and body orientation as well as sensorimotor development. These treatment goals can also be accomplished by child physical therapists, occupational therapists and remedial (PE) teachers. However, if impaired motor performance is associated with problems or impairments in one of the other clusters, a psychomotor therapist is preferable for carrying out the treatment.

E. Self-control

This cluster is designed to help children to control impulses, regulate energy, improve concentration, tolerate frustration and to act independently and autonomously. In this cluster the self-regulation of behaviour is most important. The aim is to help the child to control his impulses, actions, feelings and behaviour, and to demonstrate age-appropriate coping behaviour. For instance, reducing conflict situations by learning to cope with success and failure, or winning and losing, are goals within this cluster.

F. Self-confidence and self-expression

Here, goals are to act assertively, express oneself and one's emotions and act spontaneously. Goals in this cluster are focused on helping children who tend to internalise behaviour or who are inhibited in behaviour and movement expression. For instance, acquiring behavioural skills (like standing up for oneself and acting self-confidently) are goals that belong to this cluster. To feel more at ease in one's own body, to move more freely, to obtain a positive body attitude are more specific psychomotor goals.

G. Playing and interacting with peers

Goals in this cluster focus on social behaviour, on learning to engage in interaction and subsequently to maintain interactions and relationships with peers and adults. The primary goal of this cluster is to develop adequate (movement) behaviour while interacting with peers. For example, learning how to match and mingle with other children, playing together cooperatively, demonstrating fair play in competitive games and adopting social perspectives while playing. Furthermore, adequate interaction with adults and behaviour such as keeping an appropriate distance and learning to play by the rules can be a goal in this cluster.

Table I: The item list of the PsyMot

Domain: functions (1-26)	
1	Consciousness
2	Orientation
3	Exploration
4	Energy and drive: persistence
5	Impulse control
6	Attention
7	Movement expression
8	Movement coordination
9	Appropriateness of emotions
10	Regulation of emotions
11	Range of emotions
12	Insight
13	Body awareness
14	Body perception
15	Body image
16	Gender identity
17	Self image
18	Perceived motor competence
19	Reality testing
20	Sensation of pain
21	Sensory integration
22	Breathing
23	Exercise tolerance
24	Weight maintenance
25	Muscle power
26	Flexibility

Domain: activities and participation (27-63)	
27	Learning movement skills
28	Solving movement problems
29	Undertaking movement tasks
30	Managing level of activity
31	Managing bodily signals
32	Coping with emotions
33	Coping with stress
34	Switching over
35	Understanding body language
36	Using body language
37	Object control
38	Locomotion
39	Moving around using equipment
40	Body care
41	Getting dressed
42	Handling potential danger
43	Respect and warmth
44	Tolerance
45	Handling feedback and criticism
46	Handling social cues
47	Handling physical contact
48	Trusting and helping
49	Taking turns
50	Playing alone
51	Fantasy play
52	Onlooker play
53	Parallel play
54	Cooperative play
55	Competitive play
56	Handling play materials
57	Flexibility in play behaviour
58	Winning and losing
59	Handling rules
60	Handling social space
61	Interacting with peers
62	Movement experience in school
63	Movement experience in leisure time

Domain: environmental factors (64, 65)	
64	Protective factors *[description]*
65	External stressors *[description]*

Domain: personal factors (66, 67)	
66	Internal stressors *[description]*
67	Need for structure *low / medium / high*

Note: Items 1-63 are scored, for items 64-67 the therapist provides a short description.

The assessment procedure

The items of the PsyMot are scored in three semi-structured psychomotor sessions, varying from 30 to 60 minutes per session. The elements of the session are chosen so that each item of the item list can be observed at least two times. For each session, the activities and verbal and nonverbal interventions are prescribed but during the session the therapist is allowed to make adaptations to improve the working alliance and enhance the child's commitment. The role of the therapist is characterised by active participation, and a supportive, encouraging and playful attitude during the movement activities. During the body-oriented exercises, the therapist is patient in helping the child to focus on bodily sensations, legitimates reported feelings and sets boundaries in case of overwhelming anxiety. Subsequently, the child is invited to report subjective experiences to which the therapist responds empathically. Additionally, a limited amount of feedback on actual behaviour is given in a non-intruding and non-judgmental way, and the reaction of the child is carefully acknowledged and registered by the therapist.

In the first session, the therapist interviews the child in a semi-structured manner. The topics of the interview are concerned with the child's own ideas of his or her problems, past movement experiences, sports and playing with peers, somatic complaints, body awareness, body image, self image, feelings and emotions, trauma, coping and motivation. The questions are formulated in accordance with the level of understanding of a 6–12-year-old with average cognitive abilities. Therapists may rephrase the questions if necessary.

Joan tells the therapist she is always afraid of being ridiculed during physical education class. In the past, children from her gym club taunted her which made her angry, but she did not stand up for herself. She felt stupid afterwards. Nowadays, she often feels ashamed of herself and her physical appearance.

It is important to note that if the attention span of the child is limited, the interview can be split into several parts while movement activities of the next two sessions can be introduced in-between. The intake is used to gather information about the child so that it can be processed and used in the following sessions.

The second session is an individual movement observation combined with specific topics in an interview with the child, such as self-perceived motor competence, subjective experiences, choices and motivations. This session consists of five elements which are fully described in the guidelines of the PsyMot. They are summarised below:

(1) Introduction. The therapist supports and invites the child to explore the therapy room and its materials;
(2) Free running. The child is invited to choose tempo, route, figures, duration and stop moment;
(3) Basketball test. The child is asked to throw a basketball from five different angles and distances and is questioned about his or her expectations of success;
(4) Ball game. The therapist throws a ball and verbally and nonverbally stimulates and encourages the child to react to various playful actions;
(5) Free choice activity for the child, with specific prescriptions to intervene for the therapist, such as giving the child feedback on movement behaviour.

When the therapist throws the ball a bit faster than before, Dennis fails to catch it. Instantly, he lashes out at the therapist and kicks a plastic cone. He then notices the small emergency light near the door which he begins to study obsessively.

The third session is a movement observation with a carefully selected peer, also combined with specific topics on which the child is questioned. In this session, bodily play and interactions with a same aged child are the topic of interest. Preferably, the therapist asks the child to choose a peer with whom he or she is familiar and feels at ease. If that cannot be realised, the therapist carefully selects a cooperative child and provides extra time for mutual introduction:

(1) Introduction. Additional exploration of the materials, some small talk followed by an explanation of the rules for the interactive games;
(2) Hindrance track. The children are asked to build together an exciting but safe enough track and to demonstrate their skills;

(3) Get hold of the treasure. The therapist introduces a fantasy game in which one child will play the guard and the other child plays the conqueror of an imaginary treasure (a gold coloured ball). Each child plays one shift in each role;
(4) Steely Stan and Loosy Floosy. The therapist gives directives to the children to act like a stiff (Steely Stan) or a relaxed (Loosy Floosy) puppet and to regulate their muscle tone and breathing. In the second part, the children are invited to place small objects on each other's back and focus on sensory awareness;
(5) Free choice activity for the children, with specific interactional interventions by the therapist.

After playing a waiting game for several moments, Joan eventually takes the initiative to conquer the golden ball. She circles around 'the guard' while she cautiously avoids bodily contact. In the end, she fails to get hold of the treasure.

Evaluation and scoring

After the sessions, the therapist scores the item list and writes down additional information about specific behaviour during the sessions. The therapist evaluates problematic experiences and behaviour as seen in the sessions and as reported by the child. The scores for each item are entered into a computer program which aggregates them into domain scores and cluster scores. The raw domain and cluster scores are converted into standard scores and classified into five levels, according to ICF procedures. High item scores indicate more problematic behaviour; high cluster scores suggest treatment indications. For a quick overview of the child's psychomotor functioning and possible treatment indications, the computer program also provides a visual representation of the standard scores and categories of the domains and clusters. The scores on domains and clusters do not automatically lead to treatment plans; the therapist has to interpret them and use additional clinical information for fine-tuning individual goals and the planning of treatment in the same way that is required in solid psychological testing (Walsh and Betz, 1990). Furthermore, the standard procedure requires discussing treatment plans with the parents as well as the child.

In Figure 1 the domain and cluster scores of Joan and Dennis are presented. For Joan, all scores are in the mild and moderate range, except for self-control, which is not problematic at all. Treatment for Joan should be focussed on self-confidence and self-expression in combination with stimulating participation and enjoyment and perceived physical and motor competence. The diagnostic team concluded that Joan did not suffer from Asperger's disorder, but from social-emotional problems, particularly anxiety and a poor self-image

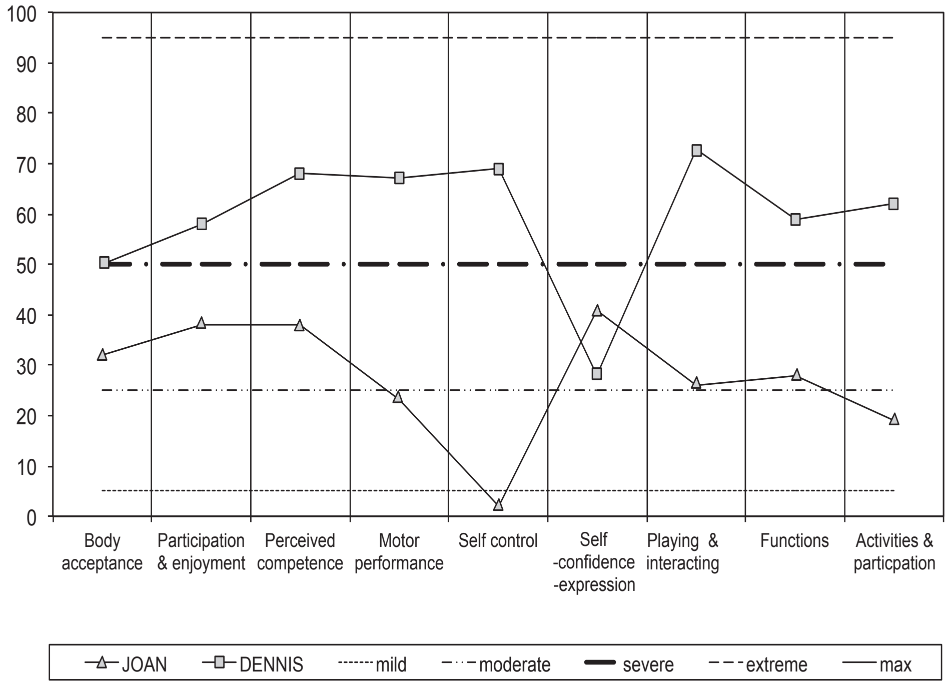

Figure 1: Standardised cluster and domain scores of Joan and Dennis

Note: numbers on the Y-axis represent standardised cluster and domain scores; higher scores indicate more problematic behaviour or more impaired functioning

For Dennis, the picture is completely different. The cluster and the domain scores are almost all in the severe range, indicating a broad range of developmental problems. Presumably, Dennis suffers from pervasive impairments that limit his potential to develop or change. However, to make a patient-tailored treatment plan, not only must the domain and clusters scores be taken into account, but the therapist needs to consider the specific item scores as well.

Dennis demonstrates impaired motor control and appears clumsy. He often stumbles, falls and fails to catch and throw balls in an age appropriate manner. His rigid behaviour and excessive focus on irrelevant details complicate the learning of new motor skills. At the same time, he seems to overestimate his motor abilities and when confronted with the resulting failure, he vents his frustration on others or on the equipment. Cooperative play leads to conflict: Dennis is unable to adapt his actions to others and becomes upset by physical contact that is initiated by others. Furthermore, he gets easily lost in his frightful fantasies during games.

Future research and development

As the case illustrations may have demonstrated, the PsyMot is a tool that only can be used by an experienced therapist, because it represents a judgmental approach to assessment (Walsh and Betz, 1990). On the one hand, quantifiable information processed by a computer is used in an objective approach; on the other hand the information must be cognitively processed by the therapist. Furthermore, realising a working alliance with the child within the context of the semi-structured assessment procedure requires clinical skills that, in general, can only be expected from an experienced therapist.

Because the PsyMot was developed for clinical use and research, validity and reliability are important issues. We have conducted two small studies which suggest that the psychometric qualities are fair to excellent. Nevertheless, the reliable use of the PsyMot can be improved by therapist training. Moreover, since the PsyMot is still lengthy and time-consuming, a short version is in preparation. Future studies will have to show whether this adaptation will be of acceptable psychometric quality. At present, we are exploring its use in different populations, such as adolescents with psychiatric disorders and children with learning problems and (mild) intellectual disability.

One of the most important future developments in our view, suggesting large shared aspects of psychomotor and dance movement therapy, is investigating the usefulness of (elements of) the PsyMot in DMT. At present we are translating the assessment procedure into English. Based on the growing interest in the evaluation of movement and body-oriented psychological treatments (Röhricht, 2009) and the necessity for assessment development

(Cruz and Berrol, 2004), we are looking forward to a more extensive dialogue with colleagues in the field of DMT with respect to assessment, diagnosis and treatment plans. To paraphrase Dijkstra (2009): the different brands of body and movement-oriented psychotherapy, whether rooted in gymnastics, sports, dance, play or body-oriented psychology, have enough in common to justify a common ground for the study of biopsychosocial aspects of movement and psychotherapy in children. Therefore, clinical assessment and diagnosis in children might be a good starting point and an outstanding opportunity for further cooperation between dance movement and psychomotor therapists and researchers.

Chapter 7

Summary and general discussion

Movement therapy tries, by appealing to the mental patient in his experiences, to improve the psychic condition of the patient.
In order to maintain oneself in society psychically in an adequate way, one must — to a certain degree — be able to move about in space and time. One must be able to be 'present', to dare to face dangers, more or less to dare to present oneself, to 'be' there…. (Salomé-Finkelstein, 1967)

In this thesis the relationships between psychiatric problems and gross motor performance in children were investigated. Two empirical approaches were followed: one in which gross motor performance was assessed in school–aged children with serious behavioural or emotional problems that came to the attention of child psychiatric services, the other consisting of assessing behavioural and emotional problems in children referred to adapted physical activity programs because of motor problems. In addition, a new tool (named PsyMot) for diagnosing (psycho)motor performance in children with psychiatric disorders was developed.

After an introduction of the topic of study (**Chapter 1**), highlighting that psychiatric and gross motor problems often seem to go hand in hand, this relation was explored in greater depth in a literature review (**Chapter 2**). For this purpose, psychiatric disorders were divided into three main groups, viz. emotional (anxiety and depression; internalizing problems), behavioural (attention deficit/hyperactivity disorder (ADHD), oppostional defiant disorder (ODD), conduct disorder (CD); externalizing problems) and pervasive developmental disorders (pervasive developmental disorder, PDD; or autism spectrum disorders). On the whole, children from all three groups displayed poor gross motor skills relative to healthy controls, supporting the idea that poor motor performance may serve as a marker for a broad range of neurodevelopmental disorders (Erlenmeyer-Kimling et al., 2000; Rasmussen and Gillberg, 2000; Vance, Arduca, Sanders, Karamitsios, Hall, and Hetrick, 2006). Moreover, two specific gross motor skills, maintaining balance and ball skills, were identified as being of special relevance with regard to the psychiatric diagnosis. Balance problems proved to be most prevalent in children with emotional, and more in particular, anxiety problems, whereas ball skills appeared to be affected predominantly in children with the inattentive subtype of ADHD, a subgroup of the children with behavioural problems. Children with pervasive developmental disorders showed severe impairments across the entire spectrum of gross motor skills. Furthermore, the majority of the children with psychiatric disorders perceived themselves as incompetent in the motor domain, except for children with ADHD who tended to overestimate themselves.

The data of the first empirical study presented in **Chapter 3** confirmed the overall hypothesis, which was derived from the review that children with psychiatric disorders indeed perform poorly on gross motor skills. In addition, neuromotor and aerobic fitness in these children was poor. Besides this general picture, specific characteristics for the three groups emerged.

- In children with emotional disorders, gross motor impairments were not as severe compared to the two other groups, although their physical fitness was equally low. Furthermore, locomotion and object control skills were unrelated in this group, a finding that sets them apart from children in the other two groups as well as from typically developing children. In view of the variable patterns of gross motor impairments in children with emotional disorders it is recommended to pay special attention to individual assessments of motor problems, in order to provide adequate psychomotor interventions to these children, a topic that will be addressed later.
- Although children with behavioural disorders performed worse on gross motor skills than those with emotional disorders, this was especially true for the locomotion subdomain, a finding that is at odds with studies indicating that ball skills are affected most in these children (Livesley, Keen, Rouse, and White 2006; Pitcher, Piek, and Hay, 2003). Furthermore, and in line with earlier findings (Harvey and Reid, 2003), both neuromotor and aerobic fitness were clearly impaired in children with behavioural disorders.
- Children with pervasive developmental disorders not only showed the largest impairments in both locomotion and object control skills, but the correlation between their scores for these subdomains was also significantly higher compared to the other psychiatric groups and typically developing children. Moreover, neuromotor and aerobic fitness scores were low, and several fitness measures correlated significantly with gross motor measures in this group. As will be discussed later, the findings in this group support the connectivity hypothesis with respect to autism spectrum disorders (Belmonte, Allen, Beckel-Mitchener, Boulanger, Carper, and Webb, 2004; Dyck, Piek, Hay, Smith, and Hallmayer, 2006).

Chapter 4 reports an experiment concerning the question if gross motor impairment in children with emotional disorders might be related to balance problems. Inspired by earlier research (Erez, Gordon, Sever, Sadeh, and Mintz, 2004), a sample of 11 children from our group of children with emotional disorders showing the highest anxiety, and a control group of 13 typically developing children, performed balance tasks. As expected, balance in the high anxious children was less stable and more attention demanding (i.e. less automatized), which was most prominent when the balance task was made more difficult by replacing the stable underground by an instable (foam) surface. These findings may indicate that balance problems may be (partly) responsible for the motor problems in children with emotional disorders. The fact that object control was affected more than locomotion could be explained by its more attention demanding nature. Object control tasks are more difficult, because one has to maintain an upright balance while handling an object in a prescribed way, than maintaining dynamic balance in a locomotion task without an additional object handling task.

Chapter 5 is concerned with children who were referred to a well known, adapted physical activity program in the Netherlands (‘ClubExtra’). The referral was based on gross motor impairments being noticed by their school teachers. Psychosocial and psychiatric assessment of these children indicated that many of them exhibited symptoms of emotional, behavioural and/or pervasive developmental disorders, and even met criteria for at least one psychiatric classification. Furthermore, these children perceived themselves incompetent in both the motor and social domain.
Anxiety disorders were most prevalent, which is in line with the evidence for a neurobehavioral link between balance and anxiety problems, as presented in Chapter 4. Furthermore, about one quarter of the children met the criteria for pervasive developmental disorders: key symptoms of autism, such as stereotyped behavior and fear of and resistance to change were abundant. These findings are compatible with results of studies indicating that children with poor motor coordination are prone to deficits in social cognition and behavior (Chen, Tseng, Hu, and Cermak, 2009; Cummings, Piek, and Dyck, 2005; Dewey, Kaplan, Crawford, and Wilson, 2002; Tseng, Howe, Chuang, and Hsieh, 2007) and with the suggestion of a common neurobiological link between motor problems and autism spectrum disorders (Allen, Müller, and Courchesne, 2004; Belmonte, Allen, Beckel-Mitchener, Boulanger, Carper, and Webb, 2004; Piek and Dyck, 2004).

In view of the close relation between psychiatric disorders and gross motor impairments in children, it seems important to complement psychiatric diagnosis with an assessment of motor behaviour. **Chapter 6** concerns the development and content of the *PsyMot*, a tool for psychomotor diagnosis. In the PsyMot procedure, the child is observed in standardized situations and questioned in a semi-structured way about self-perceived motor competence and body-experience. In view of the importance and meaning of social bodily play from a neurodevelopmental perspective (Johnson, 2011; Nelson and Luciana, 2008; Sheets-Johnstone, 2003; Smith, 2010), observation of the child's movement behaviour in interaction with a peer is also part of the PsyMot procedure.

The item pool was based on the (sub)domains of the International Classification of Functioning, Disability and Health for Children and Youth(ICF-CY) (WHO, 2003, 2007). The procedure leads to standardized scores for two domains, 'functions' and 'activities and participation', and seven cluster scores, indicating topics in need of treatment. These clusters include body acceptance, participation and enjoyment, perceived physical and motor competence, motor performance, self-control, self-confidence and self-expression and, finally, playing and interacting with peers. The aim of the PsyMot test differs from the aim of well-known tests of motor performance like the Movement ABC (Henderson and Sugden, 1992) and the TGMD-II (Ulrich, 2000) that was used in the studies reported in this thesis. That is, the PsyMot is meant to decide if a child is indicated for movement- and body-oriented therapy, and to formulate personalized treatment goals. Although gross motor behaviour is the vehicle of the treatments in question, the spectrum of treatment targets is broader and includes *experiential goals* such as improving body acceptance and awareness and enhancing bodily self-expression, *behavioural goals* such as regulating energy and controlling impulsive movements, and *social goals* such as learning to play with peers and becoming 'kinesthetically atuned' (Sheets-Johnstone, 2003). In several small studies (Broekman and ten Tusscher, 2008; de Jong and Klinkenberg, 2009; Ritbergen and Coenen, 2010; Sterk, 2011)[2] , the psychometric quality of the PsyMot in terms of interrater reliability, internal consistency and concurrent validity of the cluster scores proved to be adequate, but further investigation is needed before definite conclusions about reliability and validity can be drawn.

Theoretical implications

The findings of the studies presented in Chapters 2-5 are in line with current neurodevelopmental theories, which will be addressed below in relation to the three main child psychiatric groups that were studied. Psychosocial perspectives are also important, and thus included in the diagnostic tool presented in Chapter 6, especially in view of interaction between environmental influences and brain development.

2 These studies concern unpublished master theses.

First, our findings concur with theories about shared neuronal networks involved in balance and anxiety regulation, especially in the brainstem. The parabrachial nucleus is the core of the neural circuitry where interaction between amygdala-based emotional conditioning and cerebellum-based motor conditioning takes place (Balaban and Thayer, 2001; Erez et al., 2004). A detailed description of this neuronal network is beyond the scope of the present thesis (e.g. Balaban and Thayer, 2001), but it is involved in emotional learning, whereas its motor output may produce emotional responses. Although the causal direction, i.e., whether motor problems trigger anxiety or vice versa, has not yet been ascertained (Bart, Bar-Haim, Weizman, Levin, Sadeh, and Mitz, 2008), it appears that a process of mutual reinforcement between anxiety and motor problems plays an important role at the behavioural level. Moreover, the cerebellum is involved in conditioning processes related to implicit memory, and thus in the formation of associations between anxious feelings and balance (Erez et al., 2004; Johnson, 2011).

Second, the cerebellum may also be involved in pervasive developmental disorders. The cerebellar circuitry is essential for motor performance, but atypical cerebellar activity – or developmental damage to the cerebellum - has also been frequently reported for autism (Allen et al., 2004; Allen and Courchesne, 2003; Belmonte et al., 2004). However, this atypicality has been reported for many neurodevelopmental disorders (Diamond, 2000; Piek and Dyck, 2004), whereas in the case of autism atypicalities are not restricted to the cerebellum, but are widespread across several other brain regions (Bloom, Nelson, and Lazerson, 2001; Johnson, 2011). Nevertheless, the cerebellum is of special interest, because it is both involved in motor functioning and in serving 'higher' cognitive functions (Diamond, 2000), in particular mentalizing or 'theory of mind', i.e., the ability to understand and interact with other people on the basis of comprehending another's thought process, feelings, beliefs, and knowledge. It is also known that children with PDD generally show deficits in aspects of 'theory of mind'. According to Allen et al. (2004) dysfunctioning of the cerebellum '… might be a key contributor to the development of certain diagnostic features of autism' (p. 269). These considerations are reinforced by our studies which not only showed severe gross motor problems in children with pervasive developmental disorders, but also that children selected on the basis of poor gross motor performance showed a high prevalence of symptoms of these disorders.
To summarize, we agree with the suggestion of Allen et al. (2004), Belmonte

et al. (2004) and Piek and Dyck (2004) that cerebellar dysfunction constitutes a common neurobiological link between motor problems and PDD. However, the cerebellum is not the only brain structure involved in PDD. For instance, it has been demonstrated that cerebellar abnormality in autism is associated with abnormal brain connectivity such that the development of high local neural connectivity coincides with low long-range neural connectivity, which impairs the coordination of several functions (Baron-Cohen and Belmonte, 2005; Belmonte et al., 2004). According to Mostofsky, Burgess, and Gidley Larson (2007) this may contribute to impairments in the development of complex motor skills and communicative gestures that are specific for autism. The remarkably high correlation between locomotion and object control scores in children with pervasive developmental disorders, which is in agreement with the conclusion of Dyck, Piek, Hay, Smith, and Hallmayer (2006) that ability domains in these children are abnormally dependent, seems consistent with a 'connectivity hypothesis' with regard to autism: the weaker the interconnections between different brain structures, the stronger the negative effects on the different functions served by those structures.

Third, we would like to address the findings in children with behavioural problems. According to Krain and Castelanos (2006), several brain structures are involved in ADHD, but 'the most robustly deviant region in brain associated with ADHD is the cerebellum' (p. 441). Notwithstanding this resemblance of ADHD with PDD, the significantly lower correlation between locomotion and object handling scores in the former than in the latter group suggests that the neurodevelopmental mechanisms underlying these disorders might be different. In this regard, we refer to the neurodevelopmental view on ADHD as presented by Halperin and Healy (2010). They suggest that the clinical outcomes in ADHD reflect an interaction between deviant cortical development and compensatory mechanisms that develop throughout childhood. Especially in childhood, the period of the greatest neural plasticity, environmental enrichment by directed play and physical exercise could positively influence symptoms of ADHD by improving core neural deficits (Halperin and Healy, 2010). This leads to the speculation that therapeutic interventions such as psychomotor therapy might be more successful in targeting key symptoms in children with ADHD than in children with pervasive developmental disorders.

We finally would like to stipulate that the neurobiological account of the relationships between psychiatric disorders and gross motor behaviour does not preclude the role of psychosocial and environmental factors. In particular, as has been suggested by Cairney (2010), an environmental factor may be responsible for the co-occurrence of gross motor problems and emotional disorders. Motor problems may lead to ridicule, exclusion from social play with peers, and social isolation, which in turn may shape psychological distress (Cairney, Veldhuizen, and Szatmari, 2010), a point of view that we endorse. This may be illustrated by the fact that we chose to include items such as self-perceived competence, body experience, and interactional bodily play in the PsyMot.
We also agree that many genetic, biological and environmental interactions are still unknown and that we therefore should not favour one explanatory paradigm (psychosocial vs biological) over another. The influence of powerful environmental factors on brain development and functioning is increasingly recognised with respect to ADHD (Halperin and Healy, 2010; Sonuga-Barke and Halperin, 2010), providing support for movement interventions from neurobiological, environmental and psychosocial perspectives. Based on the notion of environmental enrichment as a powerful factor to influence neurodevelopment, Halperin and Healy (2010) proposed directed play and physical exercise as a means to promote brain growth and influence the underlying neural determinants of ADHD. Therefore, we consider the acknowledgement of a complex interplay between environmental factors and neurodevelopmental processes of outstanding importance for the development of diagnostic tools as well as for interventions.

Limitations and recommendations

As in any study, the studies presented in this thesis have their limitations. Firstly, although random selected samples drawn from well-defined populations would have been preferable, this was hampered by practical considerations. Instead, convenience samples were recruited from settings all over the country, which was regarded the second best choice to guarantee their representativity with regard to the clinical populations in question. Although most children were tested before they took part in interventions aimed at improving their functioning, some of them had already started to take part in the adapted physical activity intervention (ClubExtra). It seems difficult to conceive, however, that this factor would have influenced the relationships between the psychiatric and movement variables investigated in the studies in question.

Secondly, the TGMD-II (Ullrich, 2000) was selected to measure gross motor performance instead of the more widely used MABC, a choice that limited the possibilities to comparing our results with other studies in the field of DCD. However, this drawback is outweighed by several advantages, like the types and broad range of basic movement skills covered, and the fact that the *quality* of movement performance would be assessed. The latter aspect may be regarded as more relevant than the performance in terms of outcome measures used in the MABC. Moreover, there is increasing doubt about the status of the MABC as 'gold standard' for motor assessment, in particular with regard to its validity and discriminatory accuracy (see van Waevelde, de Weerdt, de Cock, and Smit-Engelsman, 2004; Venetsanou, Kambas, Ellinoudis, Fatouros, and Giannakidou, 2010). Furthermore, the TGMD-II is gaining ground in the field of gross motor research in children (see for instance Bonifacci, 2004; Harvey and Reid, 2005; Pan, Tsai, and Hu, 2009). For future research, it seems advisable to use both the MABC and the TGMD-II – in typically developing children as well as in children with neurodevelopmental disorders - to gain insight into their as yet unclear relationship. Preferably, this research should include longitudinal cohort studies within a neurodevelopmental approach, as recommended by Cairney (2010) and Gillberg (2010), because this approach is believed to shed more light on the causal relationships between the investigated variables than the correlational approach used in our studies.
Finally, the development of the PsyMot is still in its infancy. There is an urgent need for such an instrument for standardised clinical assessment aimed at indicating children for specific movement- and body-oriented (i.e. psychomotor) interventions. Although a number of relatively small-scaled unpublished studies seem to support the psychometric qualities of the PsyMot, further studies into these qualities and its usefulness for guiding (psychomotor) therapists in selecting appropriate interventions is necessary.

Clinical implications

Given the results of the studies presented in this thesis, and in line with neurodevelopmental perspectives (Gillberg, 2010), we recommend gross motor assessment as an integral part of the diagnostic procedure in child psychiatry. In that respect the TGMD II could serve as the instrument of choice because the quality of the movement pattern is assessed for several relevant skills. Moreover, it provides directives for remediating the observed impairments. However, we agree with Cairney, Missiuna, Veldhuizen, and Wilsson

(2008) that not only observable motor problems should be assessed, but self-appraisal in the motor domain as well. Therefore a test to measure self-perceived motor competence should also be administered. If further investigations should bear out that the psychometric qualities of the PsyMot are indeed satisfying, this tool could be used to cover motor performance and self-perceived motor competence, as well as body experience and interactional aspects of movement behaviour.

Next to advocating motor assessment in children referred to psychiatric treatment, we would also like to recommend screening for psychosocial and psychiatric symptoms in children with gross motor impairments. Apart from the results of the study reported in Chapter 5, the evidence that motor problems may be predictive for anxiety disorders (Piek et al., 2010) and schizophrenic disorders (Erlenmeyer-Kimling et al., 2000) indicates that the development of children with motor impairments should be closely monitored.

Finally, we would like to make a plea for the inclusion of psychomotor therapy in the treatment of children with psychiatric disorders. Although the pros and cons of psychomotor therapy are beyond the scope of this thesis, the interconnections and interactions between psychiatric disorders and gross motor impairments, which are addressed in psychomotor therapy, as well as theoretical accounts of their relationship, supports its use in child psychiatric practice.
However, motor interventions in child psychiatry exceed practicing selected gross motor skills. For instance, it is known that the practice of physical skills is only useful if it is accompanied by an enhancement of self-concept (Dewey and Wilson, 2001; Peens, Pienaaar, and Nienaber, 2008). For children with neurodevelopmental disorders and psychiatric symptoms, it becomes even more complicated to tailor the intervention to the specific needs of the child. Thus, motor interventions become *psycho*motor interventions, and treatment goals range from experiential, to behavioural and social.

Fortunately, the awareness that children with psychiatric disorders may benefit from movement- and body-oriented treatment approaches is increasing, and neurodevelopmental theories about possible mechanisms underlying their effects emerge (see for instance Halperin and Healy, 2010). In this regard, the advice of Rutter, Taylor, and Hersov (1994) is noteworthy: “If a particular therapy is envisaged, assessment in that mode is usually indicated”

(p. 30). Individual assessments by the use of the PsyMot might enhance the effects of specific psychomotor therapies.

To conclude, children who come to the attention of a child psychiatric service deserve standard assessment of gross motor performance, regardless of the type of psychiatric symptoms they present. Moreover, adequate psychomotor assessment aimed at indicating children for movement-oriented interventions is advisable. If clinicians overlook problems in the motor domain, the child is at risk of developing additional psychosocial problems, low physical fitness and associated health problems. Diagnosing motor problems at an early stage may not only prevent these additional problems, but may also serve to offer promising movement interventions that enhance brain development.

Samenvatting en discussie

De bewegingstherapie tracht, door de psychisch zieke mens aan te spreken in zijn belevingen, verbetering tot stand te brengen in de psychische toestand van de zieke.
Wil men zich psychisch op een adequate wijze in de maatschappij handhaven, dan zal men zich tot op zekere hoogte in ruimte en tijd moeten kunnen bewegen; men dient dan tevens present te zijn, gevaren aan te durven, zich in meer of mindere mate te presenteren, er te zijn....
(Salomé-Finkelstein, 1967)

Inleiding

Kinderen met psychiatrische stoornissen vertonen dikwijls bijzonderheden in hun bewegingsgedrag, zowel in handelingsmotoriek als uitdrukkingsmotoriek (Buytendijk, 1948, 1963). Zo worden kinderen met stoornissen in het autistisch spectrum vaak als 'onhandig' getypeerd, dat wil zeggen dat hun handelingsmotoriek minder doeltreffend en adequaat is. Kinderen met angststoornissen vallen vaak op door hun uitdrukkingsmotoriek, waarbij de nonverbale expressie geremd is. Hoewel bewegingskenmerken in de klinische praktijk van de kinderpsychiatrie wel geobserveerd - en dikwijls ook geduid – worden, ontbreekt het aan voldoende systematisch onderzoek en diagnostiek op dit gebied (Gillberg, 2010). Bewegingsonderzoek en -diagnostiek zijn echter van groot belang gezien de recente wetenschappelijke ontwikkelingen die het gebruik van bewegingsinterventies in de kinderpsychiatrie ondersteunen (zie bijvoorbeeld Bart et al., 2009; Bornman, Mittelman en Beer, 2007; Dawson en Watling, 2000; Halperin en Healy, 2010; Larun, Nordheim, Ekeland, Hagen en Heian, 2006; Lochbaum en Crews, 2006).
Bewegingsinterventies worden in de kinderpsychiatrische praktijk in Nederland doorgaans aangeboden onder de noemer 'psychomotorische therapie', terwijl in Engeland en de Verenigde Staten *dance movement (psycho)therapy* meer ingeburgerd is. In het kader van *evidence-based treatments* is het belangrijk dat de klinische praktijk gebaseerd wordt op wetenschappelijke kennis over het bewegingsgedrag van kinderen met psychiatrische stoornissen.

Bewegingsgedrag is een ruim begrip, dat inperking vraagt in het kader van een wetenschappelijke studie. In dit proefschrift worden de grofmotorische vaardigheden nader onder de loep genomen. Grofmotorische vaardigheden betreffen basale motorische vaardigheden - zoals lopen, springen, werpen – waarbij grote spiergroepen gebruikt worden. Deze onderscheiden zich van fijnmotorische vaardigheden - zoals schrijven en veters strikken - en worden ingedeeld in twee subdomeinen. Ten eerste het domein *locomotie*, ook wel verplaatsingsvaardigheden genoemd, waaronder rennen, springen, huppelen en andere manieren van voortbewegen vallen. Ten tweede het domein *object-controle*, ofwel het hanteren van objecten, zoals het gooien, vangen en schieten van ballen, of het slaan met een knuppel of slaghout (Ulrich, 2000). Deze vaardigheden zijn essentieel om te kunnen deelnemen aan sport en spel en zijn van invloed op de (psycho)sociale ontwikkeling, de competentiebeleving en het zelfbeeld, alsmede op de fysieke fitheid van kinderen. Daarom zijn ook deze aspecten in relatie tot de grofmotorische vaardigheid onderzocht.

Het doel van de studies in dit proefschrift betrof het verhelderen van de relatie tussen kinderpsychiatrische problematiek en grofmotorisch functioneren. Daarbij werd gebruik gemaakt van een combinatie van literatuuronderzoek en empirisch onderzoek. Het literatuuronderzoek betrof studies over grofmotorische vaardigheid en motorische competentiebeleving van kinderen met psychiatrische stoornissen. Vervolgens werd in een empirische studie het grofmotorisch functioneren van kinderen met psychiatrische stoornissen onderzocht. In het verlengde daarvan werd een quasi-experimentele studie naar balans – c.q. houdingsregulatie - uitgevoerd. Voorts werd onderzocht in hoeverre kinderen met grofmotorische problemen ook specifieke psychiatrische symptomen en stoornissen vertonen. Ten slotte werd een nieuw diagnostisch instrument ontwikkeld voor psychomotorische diagnostiek en indicatiestelling.

Samenvatting van de hoofdstukken

In **hoofdstuk 1** werd een algemene introductie in de thematiek gegeven. Bewegingsgedrag is een onderwerp dat relatief weinig aandacht heeft gekregen in de algemene psychologie en psychiatrie, maar hier lijkt enige verandering in te komen. Zo wordt in toenemende mate onderkend dat mensen *door middel van bewegen* met hun omgeving interageren en dat zij zichzelf en hun omgeving dus ook bewegend leren kennen (Rosenbaum, 2005). Deze gedachte is overigens in de ontwikkelingspsychologie al langer gemeengoed. Het feit dat jonge kinderen bewegend de wereld exploreren en zichzelf en hun vaardigheden in interactie met de omgeving ontwikkelen werd al door Darwin (1877) gedocumenteerd, en later door o.a. Piaget (1952), Bernstein (1967), Gibson (1988) en Thelen (2000) uitgewerkt.

In de kinderpsychiatrische literatuur is al geruime tijd aandacht voor klinisch relevante bewegingskenmerken, in eerste instantie vooral met betrekking tot het syndroom van Asperger (Wing, 1981). Momenteel brengt ook het dominante neurobiologisch perspectief met zich mee dat het motorisch functioneren meer aandacht krijgt. Daarbij staat de gedachte centraal dat juist *bewegings*ervaring als specifieke *input* het brein - en daarmee het ontwikkelingstraject - van kinderen kan beïnvloeden (Dencla, 2003; Halperin en Healy, 2010).

Het idee dat beweging en lichaamservaring benut kunnen worden voor het gunstig beïnvloeden van psychische en psychiatrische problematiek vormt de basis van de psychomotorische therapie, waarbij bewegingsobservatie al sinds lange tijd een belangrijke rol speelt.

De relatie tussen psychiatrische stoornissen en bewegingskenmerken bij kinderen werd in **hoofdstuk 2** nader toegelicht op basis van een systematische literatuurstudie. Psychiatrische stoornissen werden daartoe onderverdeeld in drie hoofdgroepen, die ook in de andere studies in dit proefschrift terugkomen, te weten: 1. Emotionele stoornissen (angst en depressie; internaliserende problematiek), 2. Gedragsstoornissen (aandachtstekort, hyperactiviteit en oppositioneel gedrag; externaliserende problematiek), en 3. Pervasieve ontwikkelingsstoornissen (PDD; autisme spectrumstoornissen). Van deze drie groepen werden de meest opvallende klinische bewegingskenmerken beschreven. Uit de geanalyseerde studies kwam naar voren dat kinderen uit alle groepen *grosso modo* over minder goed ontwikkelde motorische vaardigheden beschikken dan hun leeftijdgenootjes. Dit ondersteunt het idee dat zwakke motorische vaardigheden een indicator kunnen zijn voor een brede range van psychiatrische stoornissen (Erlenmeyer-Kimling et al., 2000; Rasmussen en Gillberg, 2000; Vance et al., 2006).
Twee specifieke motorische vaardigheden die van belang lijken voor kinderpsychiatrische diagnostiek konden worden geïdentificeerd: balans en balvaardigheid. Problemen met het uitvoeren van balanceertaken bleken specifiek voor te komen bij kinderen met angststoornissen, terwijl zwakke balvaardigheid indicatief leek voor kinderen van het onoplettende subtype van *Attention Deficit Hyperactivity Disorder* (ADHD).
Kinderen met PDD bleken op alle onderdelen over de zwakste grofmotorische vaardigheden te beschikken. Ook bleek uit de literatuur dat kinderen met psychiatrische stoornissen zichzelf niet competent voelden ten aanzien van hun motorische vaardigheden, met uitzondering van kinderen met ADHD die ertoe neigen hun vaardigheden te overschatten.
Deze zwakke motorische vaardigheden en inadequate motorische competentiebeleving bemoeilijken het deelnemen aan spel en bewegingsactiviteiten met leeftijdgenoten moeilijk is, wat een risico voor een inactieve leefstijl vormt en zowel de fysieke als psychosociale ontwikkeling kan belemmeren.

De resultaten van de empirische studie in **hoofdstuk 3** bevestigden de hypothese dat kinderen met psychiatrische stoornissen over zwakke grofmotorische vaardigheden beschikken. Daarbij bleek dat de kwaliteit van de bewegingsuitvoering minder goed was dan die van hun leeftijdgenootjes. Tevens werd gevonden dat de fysieke fitheid bij deze kinderen laag was, zowel neuromotorisch (kracht, snelheid, flexibiliteit) als wat betreft aerobe fitheid c.q.

duurvermogen. Naast dit algemene beeld, werden ook specifieke kenmerken voor de drie subgroepen gevonden.

- Kinderen met *emotionele stoornissen* presteerden minder zwak op grofmotorische vaardigheidstaken dan kinderen van de andere twee subgroepen (gedrags- en pervasieve ontwikkelingsstoornissen), maar hun fysieke fitheid was even laag. Bovendien werd geen samenhang gevonden tussen de subdomeinen locomotie en objectcontrole. Kinderen met emotionele stoornissen kunnen dus diverse motorische vaardigheidsprofielen vertonen. Dit onderstreept het belang van individueel bewegingsonderzoek bij deze subgroep teneinde passende interventies te kunnen aanbieden.
- Kinderen met *gedragsstoornissen* presteerden zwakker op grofmotorische vaardigheidstaken dan kinderen met emotionele stoornissen. Tegen de verwachting in was locomotie – en niet objectcontrole – het zwakst ontwikkeld. Daarnaast was zowel de neuromotorische als de aerobe fitheid bij deze kinderen erg laag.
- Kinderen met *pervasieve ontwikkelingsstoornissen* hadden niet alleen de zwakst ontwikkelde vaardigheden op het gebied van zowel locomotie als objectcontrole, maar ook correleerden deze domeinen significant sterker met elkaar dan in de normgroep en in de andere twee subgroepen. De sterke relaties die (alleen) gevonden werden in de PDD groep kunnen opgevat worden als steun voor de connectiviteitshypothese voor autisme, die hieronder besproken zal worden. Ook vertoonde de PDD groep een lage fysieke fitheid en bleek de neuromotorische fitheid sterk samen te hangen met grofmotorische vaardigheid.

Hoofdstuk 4 betreft een experiment waarin de vraag of de grofmotorische vaardigheidsproblemen mogelijk gerelateerd zijn aan balansproblemen, c.q. zwakke houdingsregulatie, centraal staat. Geïnspireerd door de studie van Erez, Gordon, Sever, Sadeh en Mintz (2004), selecteerden we een subgroep van 11 kinderen met een hoog angstniveau uit de onderzoeksgroep van hoofdstuk 3 en een controlegroep van 13 kinderen zonder psychiatrische problemen met een angstniveau in de normale range, die balanceertaken moesten uitvoeren. Zoals verwacht, vonden we bij de kinderen met een hoog angstniveau een minder stabiele en minder geautomatiseerde balanshandhaving. Wanneer de balanceertaak moeilijker gemaakt werd door de ondergrond instabiel te maken en de ogen te laten sluiten, waren de verschillen tussen de groepen nog duidelijker.

Deze bevindingen bieden een mogelijke verklaring voor de in hoofdstuk 3 gerapporteerde problemen met de grofmotorische vaardigheid bij kinderen met emotionele stoornissen. Deze kinderen presteerden zwakker bij objectcontrolevaardigheden dan bij locomotievaardigheden. Omdat bij objectcontrolevaardigheden niet alleen de balans gehandhaafd moet blijven, maar tevens een object (bal) op voorgeschreven wijze gehanteerd moet worden (werpen, schieten, rollen, vangen), vergen deze vaardigheden meer aandacht dan locomotievaardigheden. Omdat de balanshandhaving bij deze kinderen minder is geautomatiseerd, ligt het voor de hand dat objectcontrolevaardigheden voor hen meer problemen zullen opleveren.

In **hoofstuk 5** staat de vraag centraal in hoeverre kinderen die primair problemen vertonen in de grofmotorische vaardigheden ook specifieke psychiatrische symptomen en stoornissen vertonen. Daartoe werd een groep kinderen die deelnamen aan ClubExtra – een interventie voor kinderen met een bewegingsachterstand – onderzocht. Het bleek dat veel van deze kinderen symptomen van emotionele, gedrags-, en pervasieve ontwikkelingsstoornissen vertoonden, en dat 65% van de groep voldeed aan de criteria voor minimaal één psychiatrische stoornis. Ook voelden de kinderen zich incompetent in het motorische en het sociale domein. Naar verwachting – en in overeenstemming met de bevindingen in hoofdstuk 3 en 4 – werd een groot aantal angststoornissen bij deze groep gevonden. Daarnaast voldeed een kwart van de kinderen ook aan de criteria voor autismespectrumstoornissen (pervasieve ontwikkelingsstoornissen). Kernsymptomen van deze stoornissen, zoals stereotiepe gedragingen en weerstand tegen of angst voor veranderingen, kwamen zeer frequent voor. Deze bevindingen zijn in overeenstemming met die van andere studies waarin aanwijzingen gevonden werden dat kinderen met motorische coördinatieproblemen beperkingen vertonen in sociale cognitie en sociaal gedrag (Chen, Tseng, Hu en Cermak, 2009; Cummins, Piek en Dyck, 2005; Dewey, Kaplan, Crawford en Wilson, 2002; Tseng, Howe, Chuang en Hsieh, 2007). Hier ligt vermoedelijk een neurobiologisch verband tussen motorische problemen en autismespectrumstoornissen aan ten grondslag (Allen, Müller en Courchesne, 2004; Belmonte, Allen, Beckel-Mitchener, Boulanger, Carper en Webb, 2004; Piek en Dyck, 2004).

Gegeven de nauwe relatie tussen psychiatrische en grofmotorische problemen bij kinderen, is het van belang om bij kinderpsychiatrische diagnostiek aandacht te besteden aan bewegingsonderzoek. **Hoofdstuk 6** betreft de ontwikkeling van de *PsyMot*, een instrument voor psychomotorische diagnostiek en behandelindicaties voor kinderen. De *PsyMot* procedure bestaat uit een gestandaardiseerde bewegingsobservatie in combinatie met een semi-gestructureerd interview over thema's als lichaamsbeleving en zelfwaargenomen competentie. Gezien het belang van sociale interactie in bewegingsactiviteiten – een belang dat ook onderkend wordt binnen een neurobiologisch ontwikkelingsperspectief (Johnson, 2011; Nelson en Luciana, 2008; Sheets-Johnstone, 2003; Smith, 2010) - wordt het kind ook geobserveerd in spel en bewegingactiviteiten die het samen met een leeftijdgenootje uitvoert.

De PsyMot werd gebaseerd op de (sub)domeinen van de International Classification of Functioning, Disability and Health for Children and Youth (ICF-CY) (WHO, 2003, 2007). De scoringsprocedure leidt tot gestandaardiseerde scores op twee domeinen (functies en activiteiten/participatie) en zeven clusters die behandelindicaties betreffen. Deze clusters zijn: A. Aanvaarden van het eigen lichaam; B. Ontwikkelen van plezier in bewegen; C. Ontwikkelen van een realistische motorische competentiebeleving; D. Verminderen van een motorische achterstand; E. Verbeteren van zelfcontrole; F. Stimuleren van zelfvertrouwen en expressiviteit; en G. Ontwikkelen van samenspel en interactievaardigheden.

Het doel van de PsyMot verschilt van dat van bekende motorische tests zoals de Movement ABC (Henderson en Sugden, 1992) en de TGMD-II (Ulrich, 2000). De PsyMot beoogt een hulpmiddel te zijn om te bepalen of een kind geïndiceerd is voor psychomotorische therapie en om individuele doelstellingen voor deze vorm van therapie te formuleren. Hoewel (grofmotorisch) bewegingsgedrag het aangrijpingspunt van de therapie vormt, is het spectrum van doelstellingen breder. Het omvat *experiëntiële* doelen zoals het versterken van lichaamsbewustzijn en non-verbale expressie, *gedrags*-doelen zoals het leren reguleren van energie en impulsen, en *sociale* doelen zoals samenspel met - en fysieke afstemming op - andere kinderen. In de eerste studies naar de psychometrische kwaliteit van de PsyMot werden bij kinderen met psychiatrische problematiek en/of een licht verstandelijke handicap positieve resultaten gevonden met betrekking tot de betrouwbaarheid en validiteit van de clusters (Broekman en ten Tusscher, 2008; De Jong en Klinkenberg, 2009; Ritbergen en Coenen, 2010; Sterk, 2011). Echter, aanvullend psychometrisch onderzoek is noodzakelijk alvorens op dit punt definitieve conclusies getrokken kunnen worden.

Theoretische implicaties

De resultaten van hoofdstuk 2, 3, 4, en 5 zijn in overeenstemming met huidige neurobiologische ontwikkelingstheorieën betreffende de drie hoofdgroepen van kinderpsychiatrische stoornissen die in dit proefschrift centraal stonden. Gezien de wisselwerking tussen hersenontwikkeling en omgevingsfactoren, zijn ook psychosociale factoren van groot belang; deze factoren hebben dan ook een plaats gekregen in het diagnostisch instrument dat in hoofdstuk 6 werd beschreven.

Ten eerste zijn onze bevindingen in overeenstemming met theorieën over neuronale netwerken die betrokken zijn bij zowel angstregulatie als balanshandhaving, met name in de hersenstam. Het centrum van het neuronale circuit waar de interactie tussen emotionele conditionering vanuit de amygdala en de motorische conditionering vanuit het cerebellum plaatsvindt, is de nucleus parabrachialis (Balaban en Thayer, 2001; Erez et al., 2004). Deze is van belang bij emotionele leerprocessen, waarbij de motorische output emotionele responsen genereert. Hoewel de richting van het verband – dat wil zeggen of motorische problemen angst veroorzaken of andersom – nog onduidelijk is, speelt de wederzijdse beïnvloeding van angst en motorische problemen op gedragsniveau een belangrijke rol (Bart et al., 2008). Bovendien is het cerebellum betrokken bij conditionering tijdens impliciet leren en dus bij de vorming van associaties tussen angst en balans (Erez et al., 2004; Johnson, 2011).

Ten tweede moet vermeld worden dat het cerebellum vermoedelijk ook een rol speelt bij PDD, cq. autismespectrumstoornissen (Allen et al., 2004; Allen en Corchesne; Belmonte et al., 2004).Het cerebellum is betrokken bij zowel motorische functies als cognitieve functies zoals ‘mentaliseren’ en ‘theory of mind’, die ten grondslag liggen aan het begrip voor de gedachten en gevoelens van anderen (Diamond, 2000). Juist op dit punt hebben kinderen met PDD beperkingen. Volgens Allen et al. (2004) zou het disfunctioneren van het cerebellum dan ook een centrale factor kunnen zijn bij het ontwikkelen van de kernsymptomen van autisme. Deze opvatting wordt ondersteund door de bevindingen in de studies die gepresenteerd werden in dit proefschrift: kinderen met PDD bleken over zeer zwakke grofmotorische vaardigheden te beschikken (hoofdstuk 3) en kinderen met zwakke grofmotorische vaardigheden bleken veelvuldig kernsymptomen van PDD te vertonen (hoofdstuk 5).

Niettemin is het van belang te onderkennen dat het cerebellum niet de enige hersenstructuur is die betrokken is bij PDD (Bloom, Nelson en Lazerson, 2001; Johnson, 2011). Disfunctioneren van het cerebellum blijkt geassocieerd te zijn met abnormale connectiviteit, zodanig dat verbindingen binnen specifieke hersengebieden sterker, maar verbindingen tussen hersengebieden juist minder sterk zijn ontwikkeld dan bij gezonde kinderen. Dit leidt tot problemen in de coördinatie van aan deze gebieden gerelateerde functies (Baron-Cohen en Belmonte, 2005; Belmonte et al., 2004). Volgens Mostofsky, Burgess en Gidley Larson (2007) draagt dit tevens bij aan de motorische problemen die typerend zijn voor autisme. De opvallend hoge samenhang tussen locomotie en objectcontrole bij kinderen met PDD (hoofdstuk 3) ondersteunt de conclusie van Dyck, Piek, Hay, Smith en Hallmayer (2006) dat vaardigheidsdomeinen bij deze kinderen sterk met elkaar samenhangen en is in overeenstemming met de 'connectiviteitshypothese' over autisme.

Ten derde staan we stil bij de bevindingen bij kinderen met gedragsstoornissen. Volgens Krain and Castelanos (2006) zijn diverse hersenstructuren betrokken bij ADHD, maar vertoont het cerebellum de meest robuuste afwijkingen. Ondanks de overeenkomsten van ADHD en PDD op dit punt, suggereert de significant lagere samenhang tussen locomotie en objectcontrole bij ADHD dan bij PDD dat er sprake is van verschillende onderliggende neurobiologische mechanismen. In dit opzicht is de visie van Halperin en Healy (2010) interessant. Zij suggereren dat het klinische beeld bij ADHD de interactie weerspiegelt tussen afwijkende hersenontwikkeling en compenserende mechanismen die zich gedurende de kindertijd kunnen ontwikkelen. Juist omdat de kindertijd de periode is van de grootste neurale plasticiteit zou een 'verrijkte omgeving' in de vorm van het aanbieden van gestructureerd spel en beweging het ontwikkelingstraject - en dus de symptomen - van ADHD kunnen beïnvloeden. Dit leidt tot de speculatie dat specifieke interventies, zoals psychomotorische therapie, meer kansrijk zijn bij kinderen met ADHD dan bij kinderen met PDD.

Het neurobiologisch perspectief op de samenhang tussen kinderpsychiatrische stoornissen en grofmotorische problemen sluit de rol van psychosociale en omgevingsfactoren niet uit. Zo wordt door Cairney (2010) een keten van psychosociale factoren beschreven die een grofmotorische ontwikkelingsachterstand en emotionele problemen bij kinderen kunnen versterken. Motorische onhandigheid kan aanleiding geven tot ridiculisering, pesten, uitlachen, uitsluiten van sociaal spel en sociaal isolement, wat weer kan leiden tot emotionele problemen (zie ook Cairney, Veldhuizen en Szatmari, 2010). Dergelijke zichzelf versterkende processen treden veelvuldig op en vormen de aanleiding dat in het hier gepresenteerde diagnostisch instrument – de PsyMot – items zoals competentiebeleving, lichaamsbeleving en sociaal spelgedrag zijn opgenomen.

Ook moeten we vaststellen dat vele genetische, biologische en omgevingsfactoren nog onbekend zijn en dat we daarom niet meer belang kunnen toekennen aan één perspectief (neurobiologisch of psychosociaal). De invloed van omgevingsfactoren op de hersenontwikkeling wordt in toenemende mate onderkend, bijvoorbeeld in relatie tot ADHD (Halperin en Healy, 2010; Sonuga-Barke en Halperin, 2010) en dit ondersteunt het mogelijk belang van bewegingsinterventies vanuit een neurobiologisch, omgevings- én psychosociaal perspectief. Uitgaande van een verrijkte omgeving als krachtig instrument om de hersenontwikkeling te stimuleren, propageren Halperin en Healy (2010) gestructureerde bewegingsactiviteiten en spel als een middel om het ontwikkelingstraject bij ADHD van jongs af aan gunstig te beïnvloeden. De erkenning van het samenspel tussen neurobiologische en omgevingsfactoren is dan ook bij uitstek van belang voor de ontwikkeling van zowel diagnostische instrumenten als interventies.

Beperkingen van de studie en aanbevelingen

Zoals elk onderzoek heeft ook deze studie zijn beperkingen. Ten eerste werden de kinderen wegens praktische bezwaren niet op basis van een aselecte steekproef geworven. In plaats daarvan kwamen zij uit vijf kinderpsychiatrische instellingen en twee locaties van ClubExtra. Daarmee werd getracht de representativiteit zo veel mogelijk te waarborgen. Enkele deelnemers van ClubExtra participeerden al enige tijd in de interventie. Het lijkt echter niet aannemelijk dat dit de relatie tussen grofmotorische vaardigheid en psychiatrische problematiek heeft beïnvloed.

Ten tweede kan de keus voor de TGMD-II als beperking worden gezien, omdat de Movement ABC (MABC) frequenter gebruikt wordt voor het meten van de motorische vaardigheid. Daardoor wordt de vergelijking van onze resultaten met die van andere studies bemoeilijkt. Hier staan diverse voordelen tegenover, zoals de brede range van grofmotorische vaardigheden die de TGMD-II meet en het feit dat de *kwaliteit* van de bewegingspatronen gemeten wordt. Bovendien is er in toenemende mate kritiek op de status van de MABC als gouden standaard voor het meten van motorische vaardigheden, met name op het punt van validiteit en discriminerend vermogen (zie van Waevelde, de Weerdt, de Cock en Smit-Engelsman, 2004; Venetsanou, Kambas, Ellinoudis, Fatouros en Giannakidou, 2010). De TGMD-II lijkt mede hierdoor terrein te winnen in studies over grofmotorische vaardigheid bij kinderen (zie bijvoorbeeld Bonifacci, 2004; Harvey en Reid, 2005; Pan, Tsai en Hu, 2009). Onderzoek waarin zowel de TGMD-II als de MABC afgenomen wordt zou inzicht kunnen verschaffen in de de samenhang tussen de scores op beide instrumenten. Longitudinale studies, zoals aanbevolen door Cairney (2010) en Gillberg (2010), ouden meer inzicht kunnen verschaffen in de causale relaties tussen de motorische en psychosociale variabelen dan het door ons gehanteerde cross-sectionele design.

Als laatste moet - nogmaals – benadrukt worden dat de ontwikkeling van de PsyMot nog in de kinderschoenen staat. Er is veel behoefte aan een dergelijk instrument ter indicatie van kinderen voor specifieke bewegingsinterventies, c.q. psychomotorische therapie. Hoewel in een aantal kleine ongepubliceerde studies de psychometrische kwaliteiten van de PsyMot bevredigend waren, is meer onderzoek nodig om te kunnen beoordelen of het gebruik van het instrument daadwerkelijk wetenschappelijk veranwoord is.

Klinische implicaties

Op basis van de resultaten van de in dit proefschrift beschreven studies, en in overeenstemming met huidige neurobiologische ontwikkelingstheorieën (Gillberg, 2010), is het aan te raden om bewegingsonderzoek in de psychiatrische diagnostiek op te nemen. De TGMD-II is hiervoor een geschikt instrument omdat het de kwaliteit van de bewegingsuitvoering bij een groot aantal vaardigheden meet. Zoals ook Cairney, Missiuna, Veldhuizen en Wilson (2008) bepleiten, zou ook de subjectieve bewegings- en lichaamservaring onderzocht moeten worden. Indien de psychometrische kwaliteiten van de PsyMot inderdaad voldoende zijn, zou dit instrument geschikt zijn om genoemde aspecten naast individueel en interactioneel bewegingsgedrag te beoordelen.

Ook wordt op basis van de in hoofdstuk 5 gerapporteerde resultaten bepleit dat kinderen met problemen in de grove motoriek tevens gescreend worden op psychosociale en psychiatrische problemen, teneinde de interventie hier-op af te stemmen. Het belang hiervan wordt onderstreept door de bevinding dat motorische problemen ook indicatief kunnen zijn voor later optredende angststoornissen (Piek et al., 2010) en schizofrene stoornissen (Erlenmeyer-Kimling et al., 2000).

Ten slotte willen we, gegeven de samenhang van psychiatrische en grofmotorische problemen, een lans breken voor het opnemen van psychomotorische therapie in het behandelaanbod voor kinderen met psychiatrische problematiek. Daarbij moet benadrukt worden dat psychomotorische therapie niet beperkt is tot louter het grofmotorische domein. Het is bekend dat het oefenen van grofmotorische vaardigheden zelfs bij relatief goed functionerende kinderen slechts dan zinvol is indien dit gepaard gaat met versterking van het zelfbeeld (Dewey en Wilson, 2001; Peens, Pienaar en Nienaber, 2008). Bij kinderen met neurobiologische ontwikkelingsstoornissen en psychiatrische symptomen zal dit in nog sterkere mate het geval zijn. Het is bovendien veel moeilijker om de interventie toe te spitsen op de individuele mogelijkheden en behoeften van deze kinderen. Bewegingsinterventies, oftewel *motorische* interventies, dienen bij deze kinderen *psychomotorische* interventies te zijn, met doelstellingen die experiëntiële, gedragsmatige en interactionele aspecten van het functioneren omvatten.

Gelukkig is het besef groeiende dat kinderen met psychiatrische stoornissen baat hebben bij wat in de internationale literatuur 'movement and body-oriented treatment approaches' genoemd wordt, een opvatting die steun vindt in neurobiologische noties over mogelijke werkzame mechanismen (zie Halperin en Healy, 2010). Hier is ook het advies van Rutter, Taylor en Hersov (1994) behartenswaardig: "If a particular therapy is envisaged, assessment in that mode is usually indicated" (p. 30). Psychomotorisch onderzoek, zoals beoogd met de PsyMot, kan wellicht bijdragen aan de effectiviteit van specifieke psychomotorische interventies.

De conclusie van de hier gepresenteerde studies is dat bij kinderen die aangemeld worden voor psychiatrische diagnostiek, ook altijd een bewegingsonderzoek dient plaats te vinden, ongeacht de aard van de psychiatrische problematiek of de symptomen die zij presenteren. Wanneer clinici aan de motorische problemen voorbij gaan, loopt het kind risico op bijkomende psychosociale problemen, lage fysieke fitheid en daarmee gepaard gaande gezondheidsproblemen. Het in een vroeg stadium diagnosticeren van motorische problemen voorkomt niet alleen deze secundaire problematiek, maar biedt ook handvatten voor op het individuele kind toegespitste vormen van bewegingsinterventies, c.q. psychomotorische therapie.

References

Achenbach, T. M. (1991). *Manual for the Child Behavior Checklist/4-18 and 1991 Profile*. Burlington, VT: University of Vermont.

Achenbach, T. M., & Rescorla, L. A. (2001). *Manual for the ASEBA School-Age Forms & Profiles.* Burlington, VT: University of Vermont, Research Center for Children, Youth, and Families.

Aendekerk, E. W. C., & Verheij, F. (1997). The psychodynamics of psychomotor therapeutic process of children with conduct disorders. In A. Vermeer, R. J. Bosscher & G. D. Broadhead (Eds.), *Movement therapy across the lifespan* (pp. 76-96). Amsterdam, the Netherlands: VU University Press.

Allen, G., & Courchesne, E. (2003). Differential effects of developmental cerebellar abnormality on cognitive and motor functions in the cerebellum: An fMRI study of autism. *American Journal of Psychiatry, 160,* 262–273.

Allen, G., Müller, R. A., & Courchesne, E. (2004). Cerebellar functioning in autism: Functional magnetic resonance image activation during a simple motor task. *Biological Psychiatry, 56*, 269-278.

American Psychiatric Association (1994). *Diagnostic and statistical manual of mental disorders* (4th ed.). Washington DC: Author.

Angold, A., Costello, E. J., & Erkanli, A. (1999). Comorbidity. *Journal of Child Psychology and Psychiatry, 40*, 57-87.

Assaiante, C. (1998). Development of locomotor balance control in healthy children. *Neuroscience and Biobehavioral Reviews, 22*, 527–532.

Baker, E. D. (1998). Mixed disorder of affective and disruptive behaviors in hospitalized adolescents. A structural equations modelling approach. *Dissertation Abstracts International, 58*, 4435.

Balaban, C. D. (2002). Neural substrates linking balance control and anxiety. *Physiology & Behavior*, *77,* 469-475.

Balaban, C. D., & Jacob, R. G. (2001). Background and history of the interface between anxiety and vertigo. *Journal of Anxiety Disorders*, *15,* 27-51.

Balaban, C. D., & Thayer, J. F. (2001). Neurological bases for balance-anxiety links. *Journal of Anxiety Disorders, 15*, 53-79.

Bannerman-Haig, S. (2006). Stretching, tensing, kicking. Aspects of infantile movement in dance movement therapy with children and adolescents in special education. In H. Payne (Ed.), *Dance movement therapy. Theory, research and practice* (2nd ed., pp. 87–99). London: Routledge.

Bart, O., Bar-Haim, Y., Weizman, E., Levin, M., Sadeh, A., & Mintz, M. (2009). Balance treatment ameliorates anxiety and increases self-esteem in children with comorbid anxiety and balance disorder. *Research in Developmental Disabilities*, *30*, 486-495.

Baron-Cohen, S., & Belmonte, M. K. (2005). Autism: A window onto the development of the social and the analytic brain. *Annual Review of Neuroscience, 28*, 109–126.

Bauman, C., Löffler, C., Curic, A., Schmid, E., & von Aster, M. (2004). Motorische Entwicklung und kinderpsychiatrische Störungen. *Psychiatrie Praxis, 31*, 1-5.

Belmonte, M. K., Allen, G., Beckel-Mitchener, A., Boulanger, L. M., Carper, R.A., & Webb, S. J. (2004). Autism and abnormal development of brain connectivity. *The Journal of Neuroscience, 24,* 9228-9231.

Berkeley, S. L., Zittel, L. L., Pitney, L. V., & Nichols, S. E. (2001). Locomotor and object control skills of children diagnosed with autism. *Adapted Physical Activity Quarterly, 18*, 405-416.

Bernstein, N. (1967). *The coordination and regulation of movements*. Oxford: Pergamon.

Beyer, R. (1999). Motor proficiency of boys with attention deficit hyperactivity disorder and boys with learning disabilities. *Adapted Physical Activity Quarterly, 16*, 403-414.

Berrol, C. F. (2000). The spectrum of research options in dance/movement therapy. *American Journal of Dance Therapy, 22*, 29-46.

Berrol, C. F. (2006). Neuroscience meets dance/movement therapy: Mirror neurons, the therapeutic process and empathy. *The Arts in Psychotherapy, 33*, 302–315.

Bille, B., Briedītis, K., Steen, M., & Ekström, B. (1995). *Folke Bernadotte test*. Stockholm, Sweden: Liber Utbildingsförlaget.
Blondis, T. A. (1999). Motor disorders and attention-deficit/hyperactivity disorder. *Pediatric Clinics of North America, 46*, 899-913.
Bloom, F., Nelson, C. A., & Lazerson, A. (2001). *Brain, mind, and behaviour* (3rd ed.). New York: Worth Publishers.
Bolognini, M., Plancherel, B., Bettechart, W., & Halfon, O. (1996). Self-esteem and mental health in early adolescence. *Journal of Adolescence, 19*, 233–245.
Bonifacci, P. (2004). Children with low motor ability have lower visual-motor integration ability but unaffected perceptual skills. *Human Movement Science, 23*, 157–168.
Bornmann, B. A., Mitelman, S. A., & Beer, D. A. (2007). Psychotherapeutic relaxation: How it relates to levels of aggression in a school within inpatient child psychiatry. A pilot study. *The Arts in Psychotherapy, 34,* 216–222.
Bradshaw, J. L. (2001). *Developmental disorders of the frontostriatal system. Neuropsychological, neuropsychiatric, and evolutionary perspectives*. New York: Psychology Press.
Broekman, H., & ten Tusscher, M. (2008). *The PsyMot. An investigation of the reliability by using new and specific measures.* Master thesis. Amsterdam: VU University.
Brooks, C. (1974). *Sensory awareness*. New York: Viking Press.
Bruininks, R. H. (1978). *Bruininks-Oseretsky test of motor proficiency: Examiners' manual.* Circle Pines MN: American Guidance Service.
Buderath, P., Gärtner, K., Frings, M., Christiansen, H., Schoch, B., Konczak, J., Gizewski, E. R., Hebebrand, J., & Timmann, D. (2009). Postural and gait performance in children with attention deficit/hyperactivity disorder. *Gait & Posture, 29*, 249-254.
Buytendijk, F .J. J. (1948/1963). *Algemene theorie der menselijke houding en beweging* [General theory of human posture and movement]. Utrecht: Het Spectrum.
Byrne, B. (2000). Relationship between anxiety, fear, self-esteem and coping strategies in adolescence. *Adolescence, 35,* 215–301.
Cairney, J. (2010). Gross motor problems an psychiatric disorders in children. *Developmental Medicine & Child Neurology*, DOI: 10.1111/j.1469-8749.2010.03806.x.
Cairney, J. Hay, J., Faught, B. E., Corana, L. M., & Flouris, A. (2006). Developmental coordination disorder, age, and play: A test of the divergence in activity-deficit with age hypothesis. *Adapted Physical Activity Quarterly, 23*, 261-276.
Cairney, J., Hay, J., Faught, B., Mandigo, J., & Flouris, A. (2005). Developmental coordination disorder, self-efficacy toward physical activity, and play: Does gender matter? *Adapted Physical Activity Quarterly, 22*, 67-82.
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.
Cairney, J., Hay, J. A., Mandigo, J., Wade, T., Faught, B. E., & Flouris, A. (2007). Developmental coordination disorder and reported enjoyment of physical education in children. *European Physical Education Review, 13*, 81-98.
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 and Child Neurology, 52*, e67-e72.
Cairney, J., Hay, J. A., Wade, T. J., Faught, B. E., & Flouris, A. (2006). Developmental coordination disorder and aerobic fitness: Is it all in their head or is measurement still the problem? *American Journal of Human Biology, 18*, 66-70.
Cairney, J., Missiuna, C., Veldhuizen, S., & Wilson, B. (2008). Evaluation of the psychometric properties of the developmental coordination disorder questionnaire for parents (DCD-Q): Results from a community based study of school-aged children. *Human Movement Science, 27,* 932–940.
Cairney, J., Veldhuizen, S., & Szatmari, P. (2010). Motor coordination and emotional-behavioral problems in children. *Current Opinions in Psychiatry, 23*, 324-329.

Cantell, M., Crawford, S., & Doyle-Baker, P. K. (2007). Physical fitness and health indices in children, adolescents and adults with high or low motor competence. *Human Movement Science, 27*, 344–362.
Cantell, M. H., Smyth, M. M., & Ahonen, T. P. (1994). Clumsiness in adolescence: Educational, motor, and social outcomes of motor delay detected at 5 years. *Adapted Physical Activity Quarterly, 11,* 115-129.
Capps, L., Sigman, M., & Yirmiya, N. (1995). Self-competence and emotional understanding in high-functioning children with autism. *Developmental Psychopathology, 7*, 137-149.
Cartwright-Hatton, S, McNicol, K., & Doubleday, E. (2006). Anxiety in a neglected population: Prevalence of anxiety disorders in pre-adolescent children. *Clinical Psychology Review, 26*, 817-833.
Cavanaugh, J. T., Guskiewicz, K. M., Giuliani, C., Marshall, S., Mercer, V. S., & Stergiou, N. (2006). Recovery of postural control after cerebral concussion: New insights using approximate entropy. *Journal of Athletic Training*, 41, 305-313.
Chaix, Y., Albaret, J. M., Brassard, C., Cheuret, E., & de Castelnau, P. (2007). Motor impairment in dyslexia. The influence of attention disorders. *European Journal of Paediatric Neurology, 11*, 368-374.
Chase, M. (1953). Dance as an adjunctive therapy with hospitalized mental patients. *Bulletin of the Menninger Clinic, 17*, 219-225 .
Chen, W. H., Tseng, M. H., Hu, F. C., & Cermak, S. A. (2009). Psychosocial adjustment and attention in children with developmental coordination disorder using different motor tests. *Research in Developmental Disabilities, 30*, 1367-1377.
Cicchetti, D., & Cohen, D.J. (Eds.) (2006). *Developmental psychopathology*. New York: Wiley.
Cohen J. (1992). *Statistical power analysis for the behavioural sciences* (2nd ed). New York: Academic Press.
Costello, A. J., Edelbrock, C., Dulcan, M. K., Kalas, R., & Klaric, S. H. (1984). *Development and testing of the NIMH Diagnostic Interview Schedule for Children in a clinic population.* Rockville, MD: Center for Epidemiological Studies, National Institute for Mental Health.
Costello, E.J., Mustillo, S., Erkanli, A., Keeler, G., & Angold, A. (2003). Prevalence and development of psychiatric disorders in childhood and adolescence. *Archives of General Psychiatry, 60*, 837-844.
Cole, M., & Cole, S.R. (2004). *Development of children*. New York: Freeman.
Cox, A.D. (1994). Interviews with parents. In M. Rutter, E. Taylor, & L. Hersov (Eds.), *Child and adolescent psychiatry. Modern approaches* (pp. 34-50). New York: Blackwell Sciences.
Cummins, A, Piek, J. P., & Dyck, M. J. (2005). Motor coordination, empathy, and social behaviour in school-aged children. *Developmental Medicine & Child Neurology, 47,* 437-442.
Crawford, S. G., Kaplan, B. J., & Dewey, D. (2006). Effects of coexisting disorders on cognition and behavior in children with ADHD. *Journal of Attention Disorders, 10*, 192-199.
Cruz, R. F., & Berrol, C. F. (2004). *Dance / movement therapists in action. A working guide to research options*. Springfield Ill.: Charles C. Thomas.
Darwin, Ch. (1872). *The expression of the emotions in man and animals*. Chicago: University of Chicago Press.
Darwin, Ch. (1877). Biographical sketch of an infant. *Mind, 2*, 285-294.
Dawson, G., & Watling, R. (2000). Interventions to facilitate auditory, visual, and motor integration in autism: A review of the evidence. *Journal of Autism and Developmental Disorders, 30,* 415-421.
Deconinck, F. J. A, de Clercq, D., van Coster, R., Oostra, A., Dewitte, G., Savelsbergh, G. J. P., Cambier, D., & Lenoir, M. (2007). Sensory contributions to balance in boys with developmental coordination disorder. *Adapted Physical Activity Quarterly, 25,* 17-35.
Deconinck, F. J. A, Savelsbergh, G. J. P, De Clercq, D., & Lenoir, M. (2010). Balance problems during obstacle crossing in children with Developmental Coordination Disorder. *Gait & Posture*, DOI:10.1016/j.gaitpost.2010.05.018.
Denckla, M. B. (1974). Development of motor coordination in normal children. *Developmental Medicine & Child Neurology, 16,* 729-741.

Denkcla, M. B. (1985). Revised neurological evaluation for subtle signs. *Psychopharmacological Bulletin, 21*,773-800.
Denckla, M. B. (2003). ADHD. Topic update. *Brain Development, 25*, 383-389.
Dewey, D., Cantell, M., & Crawford, S. G. (2007). Motor and gestural performance in children with autism spectrum disorders, developmental coordination disorder, and/or attention deficit hyperactivity disorder. *Journal of the International Neuropsychological Society, 13*, 246-256.
Dewey, D., Kaplan, B. J., Crawford, S. G., & Wilson, B. N. (2002). Developmental coordination disorder. Associated problems in attention, learning, and psychosocial adjustment. *Human Movement Science, 21*, 905-918.
Dewey, D., & Wilson, B. N. (2001). Developmental coordination disorder. What is it? *Physical and Occupational Therapy in Pediatrics, 20*, 5-27.
Diamond, A. (2000). Close interrelation of motor development and cognitive development and of the cerebellum and prefrontal cortex. *Child Development, 71*, 44-56.
Dijkstra, A. (2009). 'Crossing Borders': Fourth European Congress for Psychomotricity, Amsterdam, The Netherlands, 21–23 May 2008. *Body, Movement and Dance in Psychotherapy, 4*, 67–71.
Donker, S. F., Ledebt, A., Roerdink, M., Savelsbergh, G. J. P., & Beek, P. J. (2008). Children with cerebral palsy exhibit greater and more regular postural sway than typically developing children. *Experimental Brain Research, 184*, 363-370.
Donker, S. F., Roerdink, M., Greven, A. J., & Beek, P. J. (2007). Regularity of center-of-pressure trajectories depends on the amount of attention invested in postural control. *Experimental Brain Research*, 181, 1-11.
Duarte, M., & Sternad, D. (2008). Complexity of human postural control in young and older adults during prolonged standing. *Experimental Brain Research, 191,* 265-276.
Dyck, M. .J., Piek, J. P., Hay, D., Smith, L., & Hallmayer, J. (2006). Are abilities abnormally interdependent in children with autism? *Journal of Clinical Child and Adolescent Psychology, 35*, 20-33.
Egger, H.L., & Angold, A. (2006). Common emotional and behavioral disorders in preschool children. Presentation, nosology, and epidemiology. *Journal of Child Psychology and Psychiatry, 47*, 313-337.
Ekornäs, B., Lundervold, A. J. Tjus, T., & Heimann, M. (2010). Anxiety disorders in 8-11-year-old children: Motor skill performance and self-perception of competence. *Scandinavian Journal of Psychology*, DOI:10.1111/j.1467-9450.2009.00763.x.
Emck, C., & Bosscher, R. J. (2004). Psychomotorische interventies: bewegingservaring op maat [Psychomotor interventions: Tailored movement experiences]. In G. Pool, F. Heuvel, A. Ranchor & R. Sanderman (Eds.), *Handboek psychologische interventies bij chronisch somatische aandoeningen* [Handbook of psychological interventions for people with chronic somatic diseases] (pp. 368–386). Assen: van Gorcum.
Emck, C., Bosscher, R. J., Beek, P. J., & Doreleijers, Th. (2009). Gross motor performance and self-perceived motor competence in children with emotional, behavioural, and pervasive developmental disorders. A review. *Developmental Medicine & Child Neurology, 51*, 501-517.
Emck, C., Bosscher, R. J., van Wieringen, P. C. W., Beek, P. J., & Doreleijers, Th. (2011). Gross motor performance and physical fitness in children with psychiatric disorders. *Developmental Medicine & Child Neurology, 53*, 150-156.
Emck, C., Hammink, M. N., & Bosscher, R. J. (2007). *PsyMot: Psychomotorische diagnostiek en indicatiestelling voor kinderen van 6 tot 12 jaar* [PsyMot: Psychomotor diagnosis and treatment indications for children aged six to twelve years]. Utrecht, the Netherlands: 't Web.
Erez, O., Gordon, C. R., Sever, J., Sadeh, A., & Mintz, M. (2004). Balance dysfunction in childhood anxiety. Findings and theoretical approach. *Journal of Anxiety Disorders, 18*, 341-356.

Erfer, T. (2006). Moving toward cohesion: Group dance/movement therapy with children in psychiatry. *The Arts in Psychotherapy, 33*, 238–246.
Erlenmeyer-Kimling, L., Rock, D., Roberts, S. A., Janal, M., Kestenbaum, C., Cornblatt, B., Hilldoff Adamo, U., & Gottesman, I. I. (2000). Attention, memory, and motor skills as childhood predictors of schizophrenia-related psychoses: The New York High-Risk Project. *American Journal of Psychiatry, 157, 1416–1422.*
Evaggelinou, C., Tsigilis, N., & Papa, A. (2002). Construct validity of the test of gross motor development : A cross-validation approach. *Adapted Physical Activity Quarterly, 19*, 483-495.
Evers, A. , van Vliet-Mulder, J. C., & Groot, C. J. (2000). *Documentatie van tests en testresearch in Nederland* [Documentation of tests and testresults in the Netherlands]. Assen, the Netherlands: Van Gorcum.
Feldenkrais, M. (1990). *Awareness through movement: Health exercises for personal growth.* San Francisco: Harper Collins.
Ferdinand, R. F., & Ende, J. van der (2002). DISC-IV. *Diagnostic Interview Schedule for Children* (Dutch Version). Rotterdam, The Netherlands: Erasmus MC.
Ferdinand, R. F., Heijmens Visser, J., Hoogerheide, K. N., van der Ende, J., Kasius, M. C., Koot, H. M., & Verhulst, F.C. (2004). Improving estimation of the prognosis of childhood psychopathology; combination of DSM-III-R/DISC diagnoses and CBCL scores. *Journal of Child Psychology and Psychiatry, 45*, 599–608.
Field, A. (2005). *Discovering statistics using SPSS* (2nd ed.). London: Sage.
Fischer, K. (2004). *Einführung in die Psychomotorik*, 2nd ed. [Introduction in psychomotor therapy]. München, Germany: Ernst Reinhardt.
Fliers, E. A, de Hoog, M. L. A., Franke B. , Faraone, S. V. , Rommelse, N. J., Buitelaar, J. K., et al. (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.
Fliers, E., Vermeulen, S., Rijsdijk, F., Altink, M., Buschgens, C., Rommelse, N., et al. (2009). ADHD and poor motor performance from a family genetic perspective. *Journal of the American Academy of Child and Adolescent Psychiatry, 48*, 25-34.
Fraizer, E. V., & Mitra, S. (2008). Methodological and interpretive issues in posture-cognition dual-tasking in upright stance. *Gait and Posture, 27*, 271-279.
Gendlin, E. T. (1981). *Focussing* (rev. ed.). New York: Bantam Books.
Geuze, R. H. (2003). Static balance and developmental coordination disorder. *Human Movement Science, 22,* 527-548.
Ghaziuddin, M., & Butler, E. (1998). Clumsiness in autism and Asperger syndrome. A further report. *Journal of Intellectual Disability Research, 42*, 43-48.
Ghaziuddin, M., Butler, E., Tsai, L., & Ghaziuddin, N. (1994). Is clumsiness a marker for Asperger syndrome? *Journal of Intellectual Disability Research, 38*, 519-527.
Ghaziuddin, M., Tsai, L., & Ghaziuddin, N. (1992). Brief report. A reappraisal of clumsiness as a diagnostic feature of Asperger's syndrome. *Journal of Autism and Developmental Disorders, 22*, 651-656.
Ghaziuddin, M., Quinlan, P., & Ghaziuddin, N. (2005). Catatonia in autism. A distinct subtype? *Journal of Intellectual Disability Research, 49*, 102-105.
Ghaziuddin, M., Weidmer-Mikhail, E., & Ghaziuddin, N. (1998). Comorbidity of Asperger syndrome. A preliminary report. *Journal of Intellectual Disability Research, 42*, 279-283.
Gibson, E. J. (1988). Exploratory behaviour in the development of perceiving, acting and the acquiring of knowledge. *Annual Review of Psychology, 39*, 1-41.
Gilger, J. W., & Kaplan, B. J. (2001). Atypical brain development. A conceptual framework for understanding developmental learning disabilities. *Developmental Neuropsychology, 20*, 465-481.
Gillberg, C. (2010). The ESSENCE in child psychiatry: Early symptomatic syndromes eliciting neurodevelopmental clinical examinations. *Research in Developmental Disabilities*, DOI: 10.1016/jridd.2010.06002.

Gillberg, C., Gillberg I. C., Rasmussen, P., Kadesjö, B., Söderström, H., Rasatam, M., Johnson, M., Rothenberger, A., & Niklasson L. (2004). Co-existing disorders in ADHD. Implications for diagnosis and intervention. *European Child and Adolescent Psychiatry, 13*(Suppl.), 180-192.
Gillberg, C., & Kadesjö, B. (2003). Why bother about clumsiness? The implication of having developmental coordination disorder (DCD). *Neural Plasticity, 10*, 59-68.
Gordijn, C. C. F. (1958). *Bewegingsonderwijs in het onderwijs en opvoedingstotaal.* [Physical education in schools and in educational context.]. Dissertation. Kampen, the Netherlands: Vrije Universiteit.
Gordijn, C. C. F. (1975). *Wat beweegt ons?* [What moves us?]. Baarn, the Netherlands: Bosch & Keuning.
Green, D., Baird, G., & Sugden, D. (2006). A pilot study of psychopathology in developmental coordination disorder. *Child: Care, Health and Development, 32*, 741-750.
Halperin, J. M., & Healy, D. M. (2010). The influences of environmental enrichment, cognitive enhancement, and physical exercise on brain development: Can we alter the developmental trajectory of ADHD? *Neuroscience and Biobehavioural Reviews,* DOI: 10.1016/jneubiorev.2010.07.006.
Hammink, M. N. (2003). *Psychomotorische diagnostiek binnen het kinder- en jeugdpsychiatrisch zorgveld*. [Psychomotor diagnosis in child psychiatric care]. Dissertation. Maastricht, the Netherlands: Shaker.
Hands, B., & Larkin, D. (2006). Physical fitness differences in children with and without motor learning difficulties. *European Journal of Special Needs Education, 21*, 447-456.
Harrington, R. (1994). Affective disorders. In: M. Rutter, E. Taylor & L. Hersov (Eds.), *Child and adolescent psychiatry. Modern approaches* (pp. 330-350). London: Blackwell Science.
Harter, S. (1978). Effectance motivation reconsidered: Toward a developmental model. *Human Development, 21*, 34-64.
Harter, S. (1982). The Perceived Competence Scale for Children. *Child Development, 53*, 87-97.
Harter, S. (1985). *Manual for the Self-perception Profile for Children. Revision of the Perceived Competence Scale for Children*. Denver, CO: University of Denver.
Hartman, E., Houwen, S., Scherder, E., & Visscher, C. (2010). On the relationship between motor performance and executive functioning in children with intellectual disabilities. *Journal of Intellectual Disability Research, 54,* 468-477.
Hartman, C. A., Luteijn, E., Serra, M., & Minderaa, R. (2006). Refinement of the Children's Social Behavioural Questionnaire (CSBQ): An instrument that describes the diverse problems seen in milder forms of PDD. *Journal of Autism and Developmental Disorders, 36,* 325–342.
Houwen, S., Hartman, E., Jonker, L., & Visscher, C. (2010). Reliability and validity of the TGMD-2 in primary-school-age children with visual impairments. *Adapted Physical Activity Quarterly, 27*, 143-159.
Harvey, W. J., & Reid, G. A. (2003). A review of fundamental movement skill performance and physical fitness of children with ADHD. *Adapted Physical Activity Quarterly, 20*, 1-5.
Harvey, W. J., & Reid, G. A. (2005). Attention deficit/hyperactivity disorder. APA research challenges. *Adapted Physical Activity Quarterly, 22*, 1-20.
Hattori, J., Ogino, T., Abiru, K., Nakano, K., Oka, M, & Ohtsuka, Y. (2006). Are pervasive developmental disorder and attention deficit ⁄ hyperactivity disorder distinct disorders? *Brain Development, 28*, 371–374.
Hay, J. A. (1992). Adequacy in and predilection for physical activity in children. *Clinical Journal of Sport Medicine, 2,* 192-201.
Henderson, S. E., & Sugden, D. A. (1992). *Movement Assessment Battery for Children*. London: The Psychological Corporation.
Hinshaw, S. P., Carte, E. T., Sami, N., Treuting, J. J., & Zupan, B. A. (2002). Preadolescent girls with attention-deficit/hyperactivity disorder (II). Neuropsychological performance in relation to subtypes and individual classification. *Journal of Consulting and Clinical Psychology, 70*, 1099-1111.

Houtman, I. L. D., & Bakker, F. C. (1989). The anxiety thermometer: A validation study. *Journal of Personality Assessment,* 53, 575-582.
Horlings, C. G. C., Küng, U. M., Bloem, B. R., Honegger, F., van Alfen, N., van Engelen, B. G. M., & Allum J. H. J. (2008). Identifying deficits in balance control following vestibular or proprioceptive loss using posturographic analysis of stance tasks. *Clinical Neurophysiology, 119,* 2338-2346.
Hoza, B., Gerdes, A. C., Hinshaw, S. P., Arnold, L.E., Pelham, W. E., Molina, B. S. G., et al. (2004). Self-perceptions of competence in children with ADHD and comparison children. *Journal of Consulting and Clinical Psychology, 72*, 382-391.
Johnson, M. H. (2011). *Developmental cognitive neuroscience*. Chichester, UK: John Wiley & Sons.
Jong, Y. de, & Klinkenberg, M. (2009). *Reliability of the PsyMot in trained therapists.* Master thesis. Amsterdam: VU University.
Kadesjö, B., & Gillberg, C. (1998). Attention deficits and clumsiness in Swedish 7-year-old children. *Developmental Medicine & Child Neurology, 40*, 796-804.
Kadesjö, B., & Gillberg, C. (1999). Developmental coordination disorder in Swedish 7-year-old children. *Journal of the American Academy of Child and Adolescent Psychiatry, 38*, 820-828.
Kadesjö, B., & Gillberg, C. (2001). The comorbidity of ADHD in the general population of Swedish school-age children. *Journal of Child Psychology and Psychiatry, 42*, 487-492.
Kakebeeke, T. H., Jongmans, M. J., Dubowitz, L. M. S., Schoemaker, M. M., & Henderson, S. E. (1993). Some aspects of the reliability of Touwen's examination of the child with minor neurological dysfunction. *Developmental Medicine & Child Neurology, 35*, 1097-1105.
Kaplan, H. I., & Sadock, B. J. (2004). *Synopsis of psychiatry*. Baltimore, MD: Williams & Wilkins.
Kaplan, B. J, Crawford, S., Cantell, M., Kooistra, L., & Dewey, D. (2006). Comorbidity, cooccurrence, continuum. What's in a name? *Child: Care, Health and Development, 32*, 723-731
Kaplan B.J., Dewey, D., Crawford, S., & Wilson, B. (2001). The term comorbidity is of questionable value in reference to developmental disorders. Data and theory. *Journal of Learning Disabilities, 34*, 555-565.
Kaplan, B. J., Wilson, B. N., Dewey, D., & Crawford, S. G. (1998). DCD may not be a discrete disorder. *Human Movement Science, 17*, 471-490.
Kashani, J. H., Heinfichs, T. F., Reid, J. C., & Huff, C. (1982). Depression in diagnostic subtypes of delinquent boys. *Adolescence, 17*, 943-949.
Kemoun, G., Carette P., Watelain, E., & Floirat, N. (2008). Thymocognitive input and postural regulation. A study on obsessive-compulsive disorder patients. *Neurophysiology Clinique, 38*, 99-104.
Kiphard, E. J., & Huppertz, H. (1968). *Erziehung durch Bewegung* [Education through movement]. Bad Godesberg, Germany: Durr.
Kiphard, E. J., & Schilling, F. (1970). Die Hamm-Marburger Körperkoordinationstest für Kinder (HMKTK) [Hamm-Marburger body coordination test for children]. *Monatschrift für Kinderheilkunde*, *118*, 473-479.
Kirkcaldy, B. D., Shephard, R. J., & Siefen, R. G. (2002). The relationship between physical activity and self-image and problem behaviour among adolescents. *Social Psychiatry and Psychiatric Epidemiology, 37*, 544-550.
Klein, R. G. (1994). Anxiety disorders. In: M. Rutter, E. Taylor & L. Hersov (Eds.), *Child and adolescent psychiatry. Modern approaches* (pp. 351-374). London: Blackwell Science.
Kleinhans, N. M., Richards, T., Sterling, L., Stegbauer, K. C., Mahurin, R., Clark Johnson, L., Greenson, J., Dawson, G., & Aylward, E. (2008). Abnormal functional connectivity in autism spectrum disorders during face processing. *Brain, 131*, 1000 -1012.
Koch, S. C., Cruz, R. F., & Goodill, S. W. (2001). Kestenberg Movement Profile: Performance of novice raters. *American Journal of Dance Therapy, 23,* 71–87.
Kogan, E., Lidor, R., Bart, O., Bar-Haim, Y., & Mintz, M. (2008). Comorbidity between balance and anxiety disorders: Verification in a normal population. *The Journal of Psychology, 142*, 601-613.

Kopp, S., Beckung, E., & Gillberg, C. (2009). Developmental coordination disorder and other motor control problems in girls with autism spectrum disorders and/or attention deficit/hyperactivity disorder. *Research in Developmental Disabilities.* DOI:10.1016/j.ridd.2009.09.017.

Krain, A. L., & Castellanos, F. X. (2006). Brain development and ADHD. *Clinical Psychology Review*, 26, 433–444.

Kristensen, H., & Torgersen, S. (2007). The association between avoidant personality traits and motor impairment in a population based sample of 11-12-year-old children. *Journal of Personality Disorders, 21*, 87-97.

Laban, R. (1928). *Schrifttanz.* Vienna: Universal-Edition.

Laban, R. (1960). *The mastery of movement* (2nd ed.). London: MacDonald & Evans.

Lake, D. E., Richman, J. S., Griffin, M. P., & Moorman, J. R. (2002). Sample entropy analysis of neonatal heart rate variability. *American Journal of Physiology – Regulatory, Integrative and Comparative Physiology,* 283, R789-R797.

Lalonde, R., & Strazielle, C. (2007). Brain regions and genes affecting postural control. *Progress in Neurobiology,* 81, 45-60.

Lamers-Winkelman, F. (1997). Recognition and treatment of sexually abused children. In: A. Vermeer, R. J. Bosscher & G.D. Broadhead (Eds.), *Movement therapy across the lifespan* (pp. 107-116). Amsterdam, the Netherlands: VU University Press.

Larun, L., Nordheim, L. V., Ekeland, E., Hagen, K. B., & Heian, F. (2006). Exercise in prevention and treatment of anxiety and depression among children and young people. *Cochrane Database of Systematic Reviews,* 3. Art. No.: CD004691, DOI:10.1002/14651858.CD004691.pub2.

Laszlo, J. I., & Bairstow, P. J. (1985). *Perceptual motor behaviour: developmental assessment and therapy*. New York: Praeger.

Leary, M. R., & Hill, D. A. (1996). Moving on. Autism and movement disturbance. *Mental Retardation, 34*, 39-53.

Lee, A., & Hobson, R. P. (1998). On developing self-concepts. A controlled study of children and adolescents with autism. *Journal of Clinical Psychology and Psychiatry, 39*, 1131-1144.

Lemay, M., Termoz, N., Lesperance, P., Chouinard, S., Rouleau, G., & Richer, F. (2007). Postural control anomalies in children with Tourette syndrome. *Experimental Brain Research, 179*, 525-530.

Levy, F. J. (1988). *Dance movement therapy: A healing art*. Reston: The American Alliance for Health, Education, Recreation, and Dance.

Leyten, C., Kemper, H., & Verschuur R. (1982). De MOPER fitheidstest. Handleiding en prestatieschalen 9 t ⁄m 11 jarigen [The MOPER fitness test. Manual and performance scales 9 to 11 year olds]. Haarlem, the Netherlands: De Vrieseborch.

Livesey, D., Keen, J., Rouse, J., & White, F. (2006). The relationship between measures of executive function, motor performance, and externalising behaviour in 5- and 6-year-old children. *Human Movement Science, 25*, 50-64.

Lochbaum, M., & Crews, D. (2006). Viability of cardiorespiratory and muscular strength programs for the adolescent with autism. *Complementary Health Practice Review*, *8*, 225-233.

Loman, S. (1998). Employing a developmental model of movement patterns in dance/movement therapy with young children and their families. *American Journal of Dance Therapy, 20,* 101–115.

Loman, S., & Merman, H. (1996). The KMP: A tool for dance/movement therapy. *American Journal of Dance Therapy, 18*, 29-52.

Loram, I. D., Maganaris, C. N., & Lakie, M. (2005). Active, non-spring-like muscle movements in human postural sway: How might paradoxical changes in muscle length be produced? *The Journal of Physiology*, *564*, 281-293.

Lord, C., & Rutter, M. (1994). Autism and pervasive developmental disorders. In M. Rutter, E. Taylor, & L. Hersov (Eds.), *Child and adolescent psychiatry. Modern approaches* (pp. 569-593). New York: Blackwell Sciences.

Luby, J. L., Mrakotsky, C., Heffelfinger, A., Brown, K, & Spitznagel, E. (2004). Characteristics of depressed preschoolers with and without anhedonia: Evidence for a melancholic depressive subtype in young children. *American Journal of Psychiatry, 161*, 1998-2004.
Luteijn, E., Minderaa, R., & Jackson, S. (2002). VISK. Vragenlijst voor inventarisatie van sociaal gedrag van kinderen [CSBQ. Children's Social Behaviour Questionnaire]. Lisse, the Netherlands: Swets.
Manjiviona, J., & Prior, M. (1995). Comparison of Asperger syndrome and high-functioning autistic children on a test of motor impairment. *Journal of Autism and Developmental Disorders, 25*, 23-39.
Marmorstein, N. R. (2007). Relationships between anxiety and externalizing disorders in youth. The influences of age and gender. *Journal of Anxiety Disorders, 21*, 420-432.
Martin, N. C., Piek, J. P., & Hay, D. (2006). DCD and ADHD: A genetic study of their shared aetiology. *Human Movement Science, 25*, 110-124
Massion, J. (2006). Sport et autism [Sport and autism]. *Science & Sports, 21*, 243-48.
McCarron, L. T. (1997). *McCarron assessment of neuromuscular development. Fine and gross motor abilities (MAND)*. Dallas (TX): McCarron-Dial Systems.
Merleau-Ponty, M. (1945). *Phénoménologie de la perception* [The phenomenology of perception]. Paris: Gallimard.
Miller, J.N., & Ozonoff, S. (2000). The external validity of Asperger disorder. Lack of evidence from the domain of neuropsychology. *Journal of Abnormal Psychology, 109*, 227-238.
Miyahara, M., Tsujii, M., Hori, M., Nakanishi, K., Kageyama, H., & Sugiyama, T. (1997). Brief report. Motor incoordination in children with Asperger's syndrome and learning disabilities. *Journal of Autism and Developmental Disorders, 27*, 597-603.
Miyahara, M., Möbs, I., & Doll-Tepper, G. (2001). Severity of hyperactivity and the comorbidity of hyperactivity with clumsiness in three sample sources. School, support group and hospital. *Child: Care, Health and Development, 27*, 413-424.
Moruzzi, S. Pesenti-Gritti, P., Brescianini, S., Salemi, M., Battaglia, M., & Ogliari, A. (2010). Clumsiness and psychopathology: Causation or shared etiology? A twin study with the CBCL 6-18 questionnaire in a general school-age population sample. *Human Movement Science, 29*, 326-338.
Mostofsky, S. H., Burgess, M. P., & Gidley Larson, J. C. (2007). Increased motor cortex white matter volume predicts motor impairment in autism. *Brain, 130*, 2117-2122.
Mulligan, A., Anney, R. J. L., O'Regan, M., Chen, W., Butler, L., Fitzgerald, M., et al. (2008). Autism symptoms in Attention-Deficit ⁄ Hyperactivity Disorder: a familial trait which correlates with conduct, oppositional defiant, language and motor disorders. *Journal of Autism and Developmental Disorders, 39,* 197–209.
Nelson, C. A., & Luciana, M. (Eds.) (2008). *Handbook of developmental cognitive neuroscience.* Cambridge, MA: MIT Press.
Netelenbos, J. B. (1998). *Motorische ontwikkeling van kinderen. Deel 1 en 2* [Motor development of children. Volume 1 and 2]. Amsterdam, the Netherlands: Boom.
Ozonoff, S. Young, G. S., Goldring, S., Greiss-Hess, L., Herrrera, A. H., Steele, J. S., Hepburn, S., & Rogers, S. (2008). Gross motor development, movement abnormalities, and early identification of autism. *Journal of Autism and Developmental Disorders, 38*, 644-656.
Page, J., & Boucher, J. (1998). Motor impairments in children with autistic disorder. *Child, Language, Teaching & Therapy, 14*, 233-259.
Pan, C., Tsai, C., & Chu, C. (2009). Fundamental movement skills in children diagnosed with Autism Spectrum Disorders and Attention Deficit Hyperactivity Disorder. *Journal of Autism and Developmental Disorders, 39,* 1694–1705.
Patel, M., Fransson, P.A., Lush, D., & Gomez, S. (2008). The effect of foam surface properties on postural stability assessment while standing. *Gait & Posture, 28,* 649-656.
Payne, H. (2006a). Tracking the web of interconnectivity. *Body, Movement and Dance in Psychotherapy, 1*, 7–15.
Payne, H. (2006b). *Dance movement therapy. Theory, research and practice* (2nd ed.). London: Routledge.

Pearsall-Jones, J. G., Piek, J. P., Rigoli, D., Martin, M. N., & Levy, F. (2011). Motor disorder and anxious and depressive symptomatology: A monozygotic co-twin control approach. *Research in Developmental Disabilities,* doi:10.1016/j.ridd.2011.01.042.

Peens, A., Pienaar, A. E., & Nienaber, A. W. (2008). The effect of different intervention programmes on the self-concept and motor proficiency of 7- to 9-year-old children with DCD. *Child: Care, Health and Development, 34*, 316–328.

Pesso, A. (1973). *Experience in action*. New York: New York University Press.

Pesso, A. (1988). Ego development and the body. *Bewegen en Hulpverlening, 4,* 239–248.

Petzold, H. G. (1996*). Integrative Bewegungs- und Leibtherapie* [Integrative movement and body therapy]. Paderborn: Junferman.

Petzold, H. G., & Metzmacher, B. (1997). Integrative movement therapy for children. In A. Vermeer, R.J. Bosscher & G.D. Broadhead (Eds.), *Movement therapy across the life-span* (pp. 15–46). Amsterdam, the Netherlands: VU University Press.

Piaget, J. (1952). *The origins of intelligence in children*. New York: International Universities Press.

Piek, J. P., Barrett, N. C., Smith, L. M., Rigoli, D., & Gason, N. (2010). Do motor skills in infancy and early childhood predict anxious and depressive symptomatology at school age? *Human Movement Science, 29,* 777-786.

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.

Piek, J. P., & Dyck, M. J. (2004). Sensory-motor deficits in children with developmental coordination disorder, attention deficit hyperactivity disorder and autistic disorder. *Human Movement Science, 23*, 475-488.

Piek, J. P., Pitcher, T., & Hay, D. (1999). Motor coordination and kinaesthesis in boys with attention deficit hyperactivity disorder. *Developmental Medicine and Child Neurology, 41*, 159-165.

Piek, J. P., Rigoli, D., Pearsall-Jones, J. G., Martin, N. C., Hay, D. A., Bennet, K. S., & Levy, F. (2007). Depressive symptomatology in child and adolescent twins with attention-deficit hyperactivity disorder and/or developmental coordination disorder. *Twin Research and Human Genetics, 10,* 587-596.

Pincus, S. M., Goldberger, A. L. (1994). Physiological time-series analysis: What does regularity quantify? *American Journal of Physiology. Heart and Circulatory Physiology*, 266, H1643-H1656.

Pitcher, T. M., Piek, J. P., & Barrett, N. C. (2002). Timing and force control in boys with attention deficit hyperactivity disorder. Subtype differences and the effect of comorbid developmental coordination disorder. *Human Movement Science, 21*, 919-945.

Pitcher, T. M., Piek, J. P., & Hay, D. A. (2003). Fine and gross motor ability in males with ADHD. *Developmental Medicine & Child Neurology, 45*, 525-535.

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

Prieto, T. E., Myklebust, J. B., Hoffmann, R. G., Lovett, E. G., & Myklebust, B. M. (1996). Measures of postural steadiness: differences between healthy young and elderly adults. *IEEE Transactions on bio-medical engineering,* 43, 956-966.

Probst, M., & Bosscher, R. J. (2001). *Ontwikkelingen in de psychomotorische therapie* [Developments in psychomotor therapy]. Zeist, the Netherlands: Cure & Care.

Rasmussen, P., & Gillberg, C. (2000). Natural outcome of ADHD with developmental coordination disorder at age 22 years. A controlled, longitudinal, community based study. *Journal of the American Academy of Child and Adolescent Psychiatry, 39*, 1424-1431.

Redfern, M. S., Furman, J. M., & Jacob, R. G. (2007). Visually induced postural sway in anxiety disorders. *Journal of Anxiety Disorders, 21*, 704-716.

Reid, H. M., & Norvilitis, J. M. (2000). Evidence for anomalous lateralization across domains in ADHD children as well as adults identified with the Wender Utah rating scale. *Journal of Psychiatric Research, 34*, 311-316.

Riach, C. L., & Starkes, J. L. (1994). Velocity of centre of pressure excursions as an indicator of postural control systems in children. *Gait & Posture, 2,* 167-172.
Richman, J. S., & Moorman, J. R. (2000). Physiological time-series analysis using approximate entropy and sample entropy. *American Journal of Physiology. Heart and Circulatory Physiology, 278,* H2039-H2049.
Ritbergen, B., & Coenen, C. (2010). De interbeoordelaarsbetrouwbaarheid van de PsyMot bij licht verstandelijk beperkte jongeren [The interrater reliability of the PsyMot in youngsters with mild mental handicaps]. Zwolle, the Netherlands: Windesheim University of Applied Sciences.
Roerdink, M., de Haart, M., Daffertshofer, A., Donker, S. F., Geurts, A. C. H., & Beek, P. J. (2006). Dynamical structure of center-of-pressure trajectories in patients recovering from stroke. *Experimental Brain Research,* 174, 256-269.
Rogé, B. (1984). *Manual of the Lincoln-Oseretsky developmental motor test*. Paris: Les editions du Centre de Psychologie Appliquée.
Röhricht, F. (2009). Body oriented psychotherapy. The state of the art in empirical research and evidence-based practice: A clinical perspective. *Body, Movement and Dance in Psychotherapy, 4,* 135–156.
Röhricht, F., & Priebe, S. (2006). Effect of body-oriented psychological therapy on negative symptoms in schizophrenia: A randomized controlled trial. *Psychological Medicine, 36*, 669–678.
Rosenbaum, D. A. (2005). The Cinderella of psychology. The neglect of motor control in the science of mental life and behavior. *American Psychologist*, *60*, 308-317.
Rosser Sandt, D. D., & Frey, G. C. (2005). Comparison of physical activity levels between children with and without autistic spectrum disorders. *Adapted Physical Activity Quarterly, 22*, 146-159.
Ruiz Pérez, L. M., & Graupera Sanz, J. L. (2005). New measure of perceived motor competence for children ages 4 to 6 years. *Perceptual Motor Skills, 101*, 131-148.
Rümke, H. C. (1962). Phenomenological and descriptive aspects of psychiatry. *Proceedings of the Third World Congress on Psychiatry, 17-25.*
Runhaar J., Collard, D. C. M., Singh, A. S., Kemper, H. C. G., van Mechelen, W., & Chinapaw, M. (2010). Motor fitness in Dutch youth: Differences over a 26-year period (1980–2006). *Journal of Science and Medicine in Sport, 13*, 323–328.
Rutter, M., Taylor, E., & Hersov, L. (1994/2004). *Child and adolescent psychiatry. Modern approaches*. London: Blackwell Science.
Sadock, B. J., & Sadock, V. A. (2003). *Kaplan and Sadock's synopsis of psychiatry*. Philadelphia: Lippincott Williams & Wilkins.
Salomé-Finkelstein, A. B. P. (1963). *Het openliggen bij lijders aan schizofrenie* [The unprotected openness to the world in schizophrenia]. Dissertation. Amsterdam, the Netherlands: Van Soest.
Salomé-Finkelstein, A. B. P. (1967). Enige kanttekeningen over het menselijk zich bewegen [Some remarks on human movement]. *Tijdschrift voor psychiatrie, 9,* 3-10.
Sandberg, S. T., Rutter, M., & Taylor, E. (1978). Hyperkinetic disorder in psychiatric clinic attenders. *Developmental Medicine & Child Neurology, 20*, 279-299.
Schaffer, D., Fisher, P., Lucas, C. P., Dulcan, M. K., Schwab-Stone, M. E. (2000). NIMH Diagnostic Interview Schedule for Children Version IV (NIMH DISC-IV): Description, differences from previous versions, and reliability of some common diagnoses. *Journal of the American Academy of Child and Adolescent Psychiatry*, *39*, 28-38.
Schilling, F., & Kiphard, E. J. (1974). *Körperkoordinationstest für Kinder*. Weinheim: Beltz.
Schmit, J. M., Regis, D. I., Riley, M. A. (2005). Dynamic patterns of postural sway in ballet dancers and track athletes. *Experimental Brain Research, 163*, 370-378.
Schott, N., Alof, V., Hultsch, D., & Meermann, D. (2007). Physical fitness in children with developmental coordination disorder. *Research Quarterly for Exercise and Sport, 78*, 438-450.
Sheets-Johnstone, M. (2003). Child's play: A multidisciplinary perspective. *Human Studies*, 26, 409–430.

Sigurdsson, E., van Os, J., & Forbonne, E. (2002). Are impaired childhood motor skills a risk factor for adolescent anxiety? Results from the 1958 U.K. Birth cohort and the National child development study. *American Journal of Psychiatry, 159*, 1044-1046.

Simons, J., Van Coppenolle, H., Pierloot, R, & Wauters, M. (1989). Zielgerichte Beobachtung des Begegungsverhältnis in der Psychiatrie [Goal related observation of motor behavior in psychiatry]. *Rehabilitation, 28*, 117-122.

Simons, J., Daly, D., Theodorou, F., Caron, C., Simons, J., & Andoniadou, E. (2008). Validity and reliability of the TGMD-2 in 7-10-year-old Flemish children with intellectual disability. *Adapted Physical Activity Quarterly, 25*, 71-82.

Skinner, R. A., & Piek, J. P. (2001). Psychosocial implications of poor motor coordination in children and adolescents. *Human Movement Science, 20*, 73-94.

Sklare, D. A., Konrad, H. R., Maser, J. D., & Jacob, R. G. (2001). Special issue on the interface of balance disorders and anxiety. An introduction and overview. *Journal of Anxiety Disorders, 15*, 1-7.

Smith, P. K. (2010). *Children and play.* Chichester, UK: Wiley Blackwell

Smyth, M. M., & Anderson, H.I. (2000). Coping with clumsiness in the school playground. Social and physical play in children with coordination impairments. *British Journal of Developmental Psychology, 18*, 389-413.

Sobin, C., & Sackeim, H. A. (1997). Psychomotor symptoms of depression. *American Journal of Psychiatry*, *154*, 4-17.

Sonuga-Barke E. J. S., & Halperin, J. M. (2010). Developmental phenotypes and causal pathways in attention deficit/hyperactivity disorder: Potential targets for early intervention? *Journal of Child Psychology and Psychiatry, 51,* 368–389.

Steggink, D. C. E., & Vermeer, A. (1997). Psychomotor therapy with autistic children. Possibilities and limitations. In: A. Vermeer, R. J. Bosscher & G. D. Broadhead (Eds.), *Movement therapy across the lifespan* (pp. 96-107). Amsterdam, the Netherlands: VU University Press.

Sterk, M. (2011). *Concurrent validity and internal consistency of the PsyMot*. Master thesis. Amsterdam: VU University.

Stins, J. F., & Beek, P. J. (2007). Effects of affective picture viewing on postural control. *BMC Neuroscience, 8*, 83. www.biomedcentral.com/1471-2202/8/83.

Stins, J. F., Ledebt, A., Emck, C., van Dokkum, E. H., & Beek, P. J. (2009). Patterns of postural sway in high anxious children. *Behavioral and Brain Functions 2009, 5*, 42. www.behavioralandbrainfunctions.com/content/5/1/42.

Stins, J. F., Michielsen, M. E., Roerdink, M., & Beek, P. J. (2009). Sway regularity reflects attentional involvement in postural control: effects of expertise, vision and cognition. *Gait & Posture,* 30, 106-109.

Sukumaran, S., Vickers, B., Yates, P., & Garralda, M. E. (2003). Self-esteem in child and adolescent psychiatric patients. *European Journal of Child and Adolescent Psychiatry, 12*, 190–197.

Taylor, E. (1994). Syndromes of attention deficit and overactivity. In: M. Rutter, E. Taylor & L. Hersov (Eds.), *Child and adolescent psychiatry. Modern approaches* (pp. 285-307). London: Blackwell Science.

Thelen, E. (2000). Motor development as foundation and future of developmental psychology. *International Journal of Behavioural Development, 24*, 385-397.

Tomkinson, G. R. (2007). Global changes in anaerobic fitness test performance of children and adolescents (1958–2003). *Scandinavian Journal of Medicine and Science in Sports, 17,* 497–507.

Tseng, M. H., Henderson, A., Chow, S. M., & Yao, G. (2004). Relationship between motor proficiency, attention, impulse, and activity in children with ADHD. *Developmental Medicine and Child Neurology, 46*, 381-388.

Tseng, M. H., Howe, T. H., Chuang. I. C., & Hsieh, C. L. (2007). Cooccurence of problems in activity 15 level, attention, psychosocial adjustment, reading and writing in children with developmental coordination disorder. *International Journal of Rehabilitation Research, 30*, 327-332.

Ulrich, D. A., & Sanford, C. B. (2000). *Test of Gross Motor Development (2nd ed.)*. Austin, TX: Proed.

Ulrich, B. D., & Ulrich, D. (1985). The role of balancing ability in performance of fundamental motor skills in 3-, 4-, and 5-year-old children. In J. E. Clark & J. H. Humphrey (Eds.), *Motor development* (Vol. 1, pp. 87-97). Hightstown NJ: Princeton Book Company.

Vance, A., Arduca, Y., Sanders, M., Karamitsios, M., Hall, N., & Hetrick, S. (2006). Attention deficit hyperactivity disorder, combined type, dysthymic disorder and anxiety disorders. Differential patterns of neurodevelopmental deficits. *Psychiatry Research, 143*, 213-222.

van Loon, H., Aendekerk, E. C. W., & Verheij, F. (1997). Children with pervasive developmental disorder. A non-integrated body image. In: A. Vermeer, R. J. Bosscher & G. D. Broadhead (Eds.), *Movement therapy across the lifespan* (pp. 60-76). Amsterdam, the Netherlands: VU University Press.

van Roozendaal, N. P. (1957). A method of movement-analysis with psychiatric patients. *Folia Psychiatrica, Neurologica et Neurochirugica, Neerlandica*, *57*, 356-366.

van Roozendaal, N. P. (1973). *Een methode van bewegingsonderzoek in de psychiatrische inrichting* [A method of movement observation in mental health institutions]. Zeist, the Netherlands: Jan Luiting Fonds.

van Waelvelde, H., de Weerdt, W., de Cock, P., & Smits-Engelsman, B. C. M. (2004). Aspects of the validity of the Movement Assessment Battery for Children. *Human Movement Science, 23*, 49–60.

van Wieringen, P. C. W. (1997). Dance therapy: Historical and psychological considerations. In A. Vermeer, R. J. Bosscher & G. D. Broadhead (Eds.), *Movement therapy across the lifespan* (pp. 191-215). Amsterdam, the Netherlands: VU University Press.

Veerman, J. W., Straathof, M. A. E., Treffers, D. A., Bergh, B. R. H. van der, & ten Brink, L. T. (1997). Competentie belevingsschaal voor kinderen (CBSK): Handleiding [Self-Perception Profile for Children (SPPC): Manual]. Lisse, the Netherlands: Swets & Zeitlinger.

Venetsanou, F., Kambas, A., Ellinoudis, T., Fatouros, I. , & Giannakidou, D. (2010). Can the Movement Assessment Battery for Children-Test be the ‘‘gold standard'' for the motor assessment of children with Developmental Coordination Disorder? *Research in Developmental Disabilities*, DOI:10.1016/j.ridd.2010.09.006

Verhulst, F. C., van der Ende, J., & Koot, H. M. (1997). *Handleiding voor de CBCL / 4-18* [Manual for the CBCL / 4-18]. Rotterdam, the Netherlands: Erasmus University.

Verhulst, F. C. (2008). *Leerboek Kinder- en Jeugdpsychiatrie* [Handbook Child and Adolescent Psychiatry]. Assen, The Netherlands: Van Gorcum.

Vermeer, A., Bosscher, R.J., & Broadhead, G.D. (Eds.) (1997). *Movement therapy across the life-span.* Amsterdam, the Netherlands: VU University Press.

Visser, J. (2003). Developmental coordination disorder. A review of research on subtypes and comorbidities. *Human Movement Science, 22*, 479-493.

Volkmar, F. R., Lord, C., Bailey, A., Schultz, R. T., & Klin, A. (2004). Autism and pervasive developmental disorders. *Journal of Child Psychology and Psychiatry, 45*, 135-170.

Walsh, W. B., & Betz, N. E. (1990). *Tests and assessment*. New York: Prentice-Hall.

Wall, A. E. T. (2004). The developmental skill-learning gap hypothesis. Implications for children with movement difficulties. *Adapted Physical Activity Quarterly, 21*, 197-218.

Whitmont, S., & Clark, C. (1996). Kinaesthetic acuity and fine motor skills in children with attention deficit hyperactivity disorder. A preliminary report. *Developmental Medicine and Child Neurology, 38*, 1091-1098.

Wilson, B. N., Kaplan, B. J., Crawford, B. J., Campbell, A., & Dewey, D. (2000). Reliability and validity of a parent questionnaire on childhood motor skills. *American Journal of Occupational Therapy, 54,* 484-493.

Wing, L. (1981). Asperger's syndrome: A clinical account. *Psychological Medicine, 11,* 115-129.

Wisdom, S., Dyck, M. J. , Piek, J. P., Hay, D., & Hallmayer, J. (2007). Can autism, language and coordination disorders be differentiated based on ability profiles? *European Child and Adolescent Psychiatry, 16*, 178-186.

World Health Organization (2003). *International statistical classification of diseases and related health problems, 10th revision. ICD-10*. Geneva, Switzerland: WHO.
World Health Organization (2007). *International Classification of Functioning, Disability and Health for Children and Youth* (ICF–CY). Geneva, Switzerland: WHO.
Wrotniak, B. H., Epstein, L. H., Dorn, J.M., Jones, K. E., & Kondilis, V. A. (2006). The relationship between motor proficiency and physical activity in children. *Pediatrics, 118*, 1758-1765.
Wuang, Y. P., Wang, C. C., Huang, M. H., & Su, C. Y. (2010). The effectiveness of simulated developmental horse-riding program in children with autism. *Adapted Physical Activity Quarterly*, *27*, 113-126.
Yoshida, Y., & Uchiyama, T. (2004). The clinical necessity for assessing attention deficit/hyperactivity disorder (AD/HD) symptoms in children with high-functioning pervasive developmental disorder (PDD). *European Child and Adolescent Psychiatry, 13*, 307-314.
Zwirs, B. W. C., Burger, H., Schulpen, T. W. J., Wiznitzer, M., Fedder, H., & Buitelaar, J.K. (2007). Prevalence of psychiatric disorders among children of different ethnic origin. *Journal of Abnormal Child Psychology, 35,* 556-566.

Dankwoord
Acknowledgements

Hoewel het werken aan een proefschrift voor buitenstaanders soms een solistische bezigheid lijkt, heb ik dit niet zo ervaren. In tegendeel, de betrokkenheid van anderen inspireerde me juist om verder te gaan bij de onvermijdelijke ‘dipjes’ in het proces.
Allereerst wil ik natuurlijk alle kinderen en ouders die aan dit onderzoek hebben meegewerkt danken. Dat zou ik het liefst met naam en toenaam doen, maar dat verhoudt zich slecht tot de belofte van anonieme gegevensverwerking, zoals nu eenmaal bij wetenschappelijke dataverzameling vereist. Hoewel ik slechts een deel van de tests en vragenlijsten zelf heb afgenomen, heb ik het contact met de ouders en kinderen altijd erg plezierig gevonden en was ik regelmatig geraakt door hetgeen verteld of gedaan werd – en de openheid waarmee de ‘psychomotorische’ benadering door hen tegemoet werd getreden.

Er hebben zes kinderpsychiatrische instellingen meegewerkt aan dit onderzoek en graag wil ik de betrokken psychomotorisch therapeuten, psychiaters, managers en andere medewerkers bedanken. Allereerst de mensen van de afdeling Fornhese van de Symfora groep: door jullie medewerking kreeg ik toegang tot verreweg de grootste groep kinderen met psychiatrische problemen. Hanneke Sleeuwenhoek, jij was rots in de branding en altijd bereid tot meedenken en het afnemen van PMDC’s en PsyMot’s. Veel dank gaat ook uit naar Renate van Haren, Dik van Leeuwen, Els Janse en Erik de Groot. Ook de medewerkers van de Jutters wil ik bedanken. Bertus Veldhuis, als psychomotorisch therapeut was jij mijn eerste aanspreekpunt en als ik op werkbezoek kwam was het altijd er gezellig om even een lunchpauzewandeling met hond in de duinen te maken! Ook in Curium mocht ik data komen verzamelen, met dank aan prof.dr. Treffers. Mieneke Norder, jouw enthousiasme als hoofd van de afdeling PMT was groot, en jullie zijn als PMT team erg belangrijk geweest in het begeleiden van diverse stagiairs. Lidwien Kok wil ik bedanken voor de medewerking die ik kreeg op afdeling Karakter in Ede. Lei Konsten – in dierbare herinnering – was hier mijn eerste aanspreekpunt, maar na zijn overlijden nam Erik Kuhlman in een moeilijke tijd deze rol op heel plezierige wijze over. Frits Boer en Corry Fickinger wil ik bedanken voor de medewerking bij de dataverzameling op de Bascule. Jan Willem Keuning en de medewerkers van Kores: hoewel de instroom vanuit Rotterdam beperkt bleef wil ik jullie ook hartelijk danken voor de bereidheid mee te werken en stagiairs toe te laten.

Een andere groep ouders en kinderen die deel heeft genomen aan dit onderzoek kwam van ClubExtra, een interventie voor kinderen met een bewegingsachterstand. Corina van Doodewaard, jij staat aan de wieg van dit project en je was meteen bereid me de juiste mensen te wijzen, waarvoor dank. Simone van der Horst en Aleida Nota: jullie bedankt voor je enthousiasme medewerking op de locaties Zwolle en Amersfoort.

De dataverzameling heeft plaatsgevonden met behulp van vele studenten, te weten: Thea de Bijl en Tessa de Baat, Sanne Rengelink en Jan Burghout, Bianca van Milligen en Daphne Schouten, Claudia Costa en Sietske Reehorst, Esther Alblas en Stefanie Kosterink, Daphne Teune en Annelies Jonkman, Claudia Costa en Sietske Reehorst, Minke van der Kamp, Ellen Koeman en Janneke de Vor, Rob van den Hoven en Lenneke van Tol, Renske van het Kaar, Marion Pronk en Maike Spijker, Inge Zomervrucht en Joanne Goedegebuuren, Hanneke van Dongen en Liesjet van Dokkum, Jenneke Bruins en Wieteke Boerman, Karin Tiele en Floor Geerlings, Laura Vink en Karien Zuidam. Ook bij het ontwikkelen van de PsyMot zijn velen betrokken geweest: Janneke Aarts en Dewy van Hoogmoed, Sandra van Ooijen en Dieuwer Berks, Hanneke Broekman en Marieke ten Tusscher, Yvonne de Jong en Maaike Klinkenberg, Marieke Coenen en Bas van Ritbergen en recent nog Maayke Sterk. Heel veel dank voor jullie inspanningen en betrokkenheid!

En dan de collegae! Ten eerste Mia Scheffers. Gedurende onze beider 'PMT loopbanen' zijn wij elkaar telkens weer tegengekomen en met jou is het altijd goed vertoeven, zowel privé als op het werk. Je bent erg belangrijk geweest in de jaren dat ik moeite had mijn draai te vinden op de FBW en ik betreur het nog steeds dat ik je niet heb kunnen overtuigen te blijven. Maar goed, een voordeel is dat er weer nieuwe mogelijkheden zijn ontstaan om onze ludieke scholenstrijd te cultiveren. John Stins dank ik hartelijk voor het feit dat hij op voortvarende wijze de balansstudie mede ter hand nam toen Annick Ledebt met zwangerschapsverlof ging. Jouw schrijfkunst is jaloersmakend en inspirerend, ik hoop dat ik van je mag blijven leren. Ook Annick dank ik voor haar inzet bij deze studie en het mede begeleiden van de betrokken studenten. Marco Hoozemans, jou dank ik voor de betrokkenheid bij het PsyMot onderzoek en je *bootstrap* kwaliteiten. Jolanda van Rijssen, Thomas Scheewe, Pam Kaspers, Hanneke van Dongen: het was leuk om met jullie als oud FBW-studenten contact te houden in jullie rol als promovendi! Ook de mensen van het (studie)secretariaat Eugiene Langendijk, Steve Barker, Lu-

cienne Heijnen, Rita Platteel en Annelies de Boer wil ik bedanken. Altijd fijn voor een praatje en een kop koffie en hoe vaak heb ik jullie niet vanuit huis gemaild voor van-alles-en-nog-wat…
De collegae van Windesheim, tegenwoordig *University of Applied Science*, hielden mij met beide voeten op de grond van de beroepspraktijk: Luuk Sietsma, Henriette van der Meijden, Janet Moeijes, Paul Hekking, Lia van der Maas, Paul Verschuur en vele anderen: dank voor jullie interesse en samenwerking op diverse PMT-fronten.

De leden van de werkveldgroep kinder- en jeugd van de Nederlandse Vereniging voor Psychomotorische Therapie waren van zeer speciale betekenis; beste Hanneke Sleeuwenhoek [alweer!], Mieneke Norder, Edith Sierink, Bertus Veldhuis, Lei Konsten (in herinnering), Maurits Uijting, Charlotte Smit, Renee de Weerd, Rene Blom en Caroline Houben: door jullie was het voor mij het mogelijk de praktijk van de PMT in het zicht te houden en te vebinden met het onderzoek. De vergaderingen – met koekjes en hond(en) – zijn altijd zinvol en gezellig, en de voortzettingen van de vrijdagmiddagvergaderingen in de vorm van borrels en etentjes zijn altijd kleine feestjes!

Ook de research groep van de Bascule, geleid door Theo Doreleijers, ben ik zeer veel dank verschuldigd. Wat heb ik veel geleerd van jullie door de jaren heen! Het was heerlijk om in een groep onderzoekers, rijp en groen, te verkeren voor wie de psychiatrische kant van mijn onderzoek bekend was. Veel dank voor Lucres Nauta, Charlotte Geluk, Lieke van Domburgh, Carmen Paalman, Annelou de Vries en alle anderen die in de loop der tijd deelnamen of zijn gaan deelnemen.

De leden van de leescommisie wil ik danken voor de snelle en zorgvuldige wijze waarop zij het manuscript hebben beoordeeld. Prof. Dr. Helen Payne, many thanks for your quick and insightful comments on the manuscript. Also, I am grateful to Prof. Dr. Savid Sugden for reviewing the manuscript. Prof.dr. Francien Lamers-Winkelman dank ik, ook omdat zij de PMT nooit uit het oog verloren heeft. Dank aan Prof.dr. Frits Boer en dr. John van de Kamp voor het contrsuctieve commentaar dat zij leverden.

En dan mijn begeleiders gedurende dit traject. Ruud Bosscher, beste Ruud, je was als co-promotor vanaf het begin betrokken. En welke stormen er ook opstaken, van welke kant de wind ook kwam, jij hielp me altijd om op koers te blijven. Piet van Wieringen, beste Piet, je bent later ingevoegd in het team en je hebt op dynamische wijze bijgedragen aan verdieping en versnelling. Peter Beek, beste Peter, je was wat meer op afstand, maar je sprong aan boord op cruciale momenten en gelukkig heb je het schip niet laten zinken. Theo Doreleijers, beste Theo, heel veel dank dat ik me mocht scharen bij jouw vloot van onderzoekers, voor je flexibiliteit en stuurmanskunsten, voor je warme betrokkenheid en frisse ideeën.

Christine Zwerver, heel veel dank voor de toestemming om het werk van Dolf Zwerver te mogen gebruiken voor de voorkant van dit proefschrift. Voor het deskundig vormgeven van de omslag en de uitnodigingen dank ik Trudy Bruil. De Nederlandse Vereniging voor Psychomotorische Therapie, het Jan Luiting Fonds, 't Web en Mare-didakt dank ik voor de sponsoring van deze uitgave. Pim Hoek, Sander Fauth, Inge van Driel, Gert van Driel, Jesse Bussemaker en Henk Plant: dank voor jullie hulp in dezen. Mijn paranimphen Jos de Haan en Hanneke Sleeuwenhoek, jullie waren geweldig in de manier waarop jullie mij hebben bijgestaan: praktische adviezen, gezellige etentjes, mailtjes en allerhande regeldingen.
En dan mijn thuisfront. Richard en 'de beestenboel'. Wat zou het leven en werken saai zijn zonder jullie. De poezen die precies op de stapel artikelen willen zitten als ik die nodig heb en de hond Joris die trouw aan mijn voeten ligt maar ook om de broodnodige wandelpauzes vraagt. Een man die zwetend van het hardlopen binnenkomt en bedacht heeft dat er *nu* toch echt even koffie moet worden gedronken. Maar die ook zo even ziet dat er nog een foutje in de tekst zit. Onbetwist onmisbaar.

Curriculum Vitae

By turning full attention to bodies and movement, we can trace out ways in which corporeal-kinetic understandings of the vulnerability of our own body is built up, and in being built up, is the basis of our understandings and appreciations of the movement possibilities and limitations – the vulnerabilities – of others in our movement interactions with them (Sheets Johnstone, 2003)

Claudia Emck was born August 8th 1959 in Utrecht, the Netherlands, where she also attended high school (O.S.G. Hendrik van der Vlist). She finished her education as a teacher in Physical Education (The Hague / Arnhem) in 1982 and worked several years as a PE teacher in elementary schools. Next, she followed the Advanced Course in Psychomotor Therapy (Amsterdam), from which she graduated in 1989. Between 1988 and 1998 she worked as a psychomotor therapist in several (psychiatric) hospitals, and she specialised in youth psychiatry at the University Medical Center in Utrecht. In 1998 she obtained her Master's degree (cum laude) in Clinical and Health Psychology at the University of Utrecht. From 1996-2004 she was part-time coordinator of the Advanced Course in Psychomotor Therapy at the University of Applied Sciences Windesheim in Zwolle. From 1998-2000 she worked as a behavioural scientist at the University Medical Center in Utrecht, where she investigated early onset psychosis. In 2001 she started to work as a lecturer and researcher on psychomotor therapy at the Faculty of Human Movement Sciences, VU University Amsterdam. From 2004-2008, she also performed research on psychomotor assessment at the University of Applied Sciences Windesheim in Zwolle. Furthermore, she founded the Expert group child- and adolescent psychiatry of the Dutch Federation of Psychomotor Therapy, participated in several national projects on research and education in the field of psychomotor therapy and published several books, chapters and articles about psychomotor therapy in Dutch.

Selection of publications

Publications related to this thesis in Dutch

Emck, C., Bosscher, R.J. & Doreleijers, Th. (2004). Psychomotorisch functioneren van kinderen met psychiatrische stoornissen: onderscheid en verscheidenheid. In *Congresbundel 'De rekkelijken en de preciezen'* (pp. 107-119). Utrecht: NVPMT.

Emck, C., Bosscher, R.J. & Doreleijers, Th. (2004). Bijzondere bewegers. Over psychomotoriek en kinderpsychiatrie. *Tijdschrift voor Psychomotorische Therapie, 10(4)* , 36-47.

Emck, C. (2005).Het optimaliseren van het psychomotorisch diagnostisch construct. *Tijdschrift voor Psychomotorische Therapie*, *11(2)* , 46-50.

Emck, C. (2005). Een diagnostische procedure voor psychomotorische therapie. In J. de Lange (red.), *Een vak apart. Artikelen over psychomotorische therapie (*pp 119-137). Zwolle: 't Web.

Emck, C. & Sleeuwenhoek, J.C. (2005). Beweging in Fornhese. De psychomotoriek van kinderen met emotionele, gedrags- en/of ontwikkelingsstoornissen. *SymForum, wetenschappelijk tijdschrift Symfora groep*, *6*, 5-12.

Emck, C. & Sleeuwenhoek, J.C. (2005). Psychomotoriek bij kinderen. *SymForum, wetenschappelijk tijdschrift Symfora groep* (themanummer onderzoek), *6*, 3.

Emck, C. & Sleeuwenhoek, J.C. (2006). Proefballon bij Fornhese. Een pilotonderzoek naar bewegingsgedrag in de kinderpsychiatrie. *Tijdschrift voor Vaktherapie, 2(1)*, 3-11.

Van der Hoeven, M., Zomervrucht, I., & Emck, C. (2006). Onhandig, maar wat nog meer? Onderzoek naar psychosociale problemen bij kinderen met een bewegingsachterstand. *Tijdschrift voor Vaktherapie, 2(3),* 28-36.

Jonkman, A. , Teune, D. & Emck, C. (2007). PDD en DCD: een paar apart? Motorische problemen bij kinderen met een pervasieve ontwikkelingsstoornis. *Tijdschrift voor Vaktherapie*, *3(1)*, 11-21.

Emck, C., Geerlings, F., Nota, A. & Tiele, K (2007). Club Extra Amersfoort: meer dan bewegen alleen. Een onderzoek naar psychosociale problemen bij kinderen die deelnemen aan Club Extra Amersfoort. *'t Web, 2007,* 7-17.

Emck, C., Hammink, M.N.& Bosscher, R.J. (2007). *PsyMot*. *Psychomotorische diagnostiek en indicatiestelling voor kinderen van 6 tot 12 jaar*. Utrecht: 't Web.

Emck, C. (2007). Scoren en erbij blijven. Deel 1: de ontwikkeling van de PsyMot. *Tijdschrift voor Vaktherapie, 3(2)*, 41-49. Ook verschenen in het *Tijdschrift voor Psychomotorische Kindertherapie*, *2007(3)*, 3-13.

Emck, C. (2007). Scoren en erbij blijven. Deel 2: Terry in beweging. *Tijdschrift voor Vaktherapie, 3(3),* 19-26. Ook verschenen in het *Tijdschrift voor Psychomotorische Kindertherapie, 2008(1),* 3-13.

Milligen, B. van, Schouten, D & Emck, C. (2007). “Ik ben de beste keeper van de school”. Over motoriek en competentiebeleving in de kinderpsychiatrie. *Tijdschrift voor Vaktherapie, 3(4),* 11-17.

Emck, C. & van der Kamp, M. (2008). Te bang om te bewegen? Het bewegingsgedrag van kinderen met angststoornissen. *Tijdschrift voor Vaktherapie, 4(1)*, 19-25.

Emck, C., Bosscher, R.J., Van Wieringen, P.C.W., Beek, P.B., & Doreleijers, T. (2010). Opvallend, onhandig, onbesuisd of onzeker? Psychomotorische kenmerken van kinderen met psychiatrische stoornissen. In J. de Lange (red.) *Psychomotorische therapie. Lichaams- en bewegingsgerichte interventies in de GGZ* (pp. 195-227). Amsterdam: Boom

Publications in English

Emck, C. (2004). Psychomotor functioning of children with psychiatric disorders. *Portuguese Review of Psychomotricity*, *3*, 61-69.

Schothorst, P.F., Emck, C. & van Engeland, H. (2006). Characteristics of early psychosis. *Comprehensive Psychiatry*, *47,* 438-442.

Emck,C., Bosscher, R.J., Dorelijers, Th. & Beek, P. (2008). Gross motor performance and perceived motor competence of children with mental disorders. *Developmental Medicine & Child Neurology, 51*, 501-517.

Stins, J.F. Ledebt, A., Emck, C., Van Dokkum E.H., & Beek, P.J. (2009). Patterns of postural sway in high anxious children. *Behavioral and Brain Functions*, 5:42.

Emck, C. & Bosscher, R.J. (2010). The PsyMot: an instrument for psychomotor diagnosis and indications for treatment. *Body, Movement and Dance in Psychotherapy.* iFirst, 1-13.

Emck, C., Bosscher, R.J., van Wieringen, P.C.W., Doreleijers, Th., & Beek, P.J. (2011). Gross motor performance and physical fitness in children with psychiatric disorders. *Developmental Medicine & Child Neurology, 53,* 150-156.

Emck, C., Bosscher, R.J., van Wieringen, P.C.W., Doreleijers, Th., Beek, P.J. (2011). Psychiatric symptoms in children with gross motor problems *[in revision]*.