

Double trouble? Movement behaviour and psychiatric conditions in children: An opportunity for treatment and development



Claudia Emck, Ph.D*

Faculty of Human Movement Science, Research institute MOVE, VU University Amsterdam, Van der Boerhorststraat 9, 1081 BT Amsterdam, The Netherlands

ARTICLE INFO

Keywords:

Dance/movement therapy
Child psychiatry
Neurodevelopmental disorders
Movement observation
Gross motor performance
PsyMot procedure

ABSTRACT

Children with neurodevelopmental disorders often show problems in movement behaviour. Clinical motor features such as clumsiness, odd postures, hyperactivity and tics occur frequently in children with psychiatric conditions. Most dance/movement therapists recognize these, and consequently tailor treatment to the abilities of their clients. In view of treatment strategies, it is important to know which motor features are associated with which psychiatric conditions, and how movement problems be influenced by movement interventions. Therefore, this article focuses on clinical movement features, gross motor problems, neurodevelopmental aspects and movement interventions for children with emotional, behavioural and autism spectrum disorders.

© 2014 Elsevier Ltd. All rights reserved.

Movement behaviour in psychology and psychiatry

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 and continue to be neglected by mainstream 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 as mere epiphenomena, and even when they are deemed of clinical significance, little information is provided on this topic in psychiatric textbooks. Motor abnormalities do receive attention in psychiatry as far as they concern side-effects of pharmacotherapy. According to Gillberg and Kadesjö (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 & Sackeim, 1997) and as a negative symptom in schizophrenia (Röhrlich & Priebe, 2006).

Movement behaviour in developmental perspective

Interestingly, in developmental psychology and child psychiatry movement behaviour has since long been a focus of attention. 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 performance 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

* Tel.: +31 61 3962599/30 2318904; fax: +31 20 5988529.
E-mail addresses: Claudia.emck@gmail.com, c.emck@vu.nl

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, & Wilson, 2002; Piek, Baynam, & Barrett, 2006; Skinner & Piek, 2001; Smyth & Anderson, 2000; Wrotniak, Epstein, Dorn, Jones, & Kondilis, 2006).

In child psychiatry, movement behaviours have received due attention as potentially relevant clinical features. Rutter, Taylor, and Hersov (2004) pointed to several significant motor abnormalities, 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) psychomotor features, such as ill-coordinated movements and odd postures, 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 (Chaziuddin, Tsai, & Ghaziuddin, 1992; Ozonoff et al., 2008; Wing, 1981). 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, & 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 dominate 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 Denckla (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.

Clinical movement observation

During the mid-20th century, movement- and body-oriented therapies came to the fore. Several forms of such therapies 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, 2009; van Wieringen, 1997). 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 & Berrol, 2004; Loman & Merman, 1996; Payne, 2006).

In contrast to the USA and the UK, movement observation in continental Western-European psychiatry grew out of physical education, as teachers were assigned to activate psychiatric patients by means of offering games, gymnastics, dance, and sports (Probst & Bosscher, 2001). In Germany, Ernst Kiphard, a sports teacher and originator of the ‘Psychomotorische Übungsbehandlung’, introduced the ‘Trampolin-Körperkoordinations-Test’ and later the ‘Hamm-Marburger Körperkoordinationstest’ for clinical purposes in child psychiatry (Kiphard & Schilling, 1970). 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, 1973). Based on phenomenological traditions, particularly on the work of Merleau-Ponty (1945) and Buytendijk (1948, 1963), van Roozendaal developed a method of systematic movement observation in clinical psychiatry. 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, & Wauters, 1989).

Thus, although clinical movement observation of psychiatric patients is rooted in different traditions, throughout the Western world movement behaviour is accepted by therapists as a clinically significant feature. Yet, it seems that scientifically valid knowledge about which movement features are associated with which psychiatric conditions, and, to what extent movement problems can be influenced by interventions, is still scarce. Given the importance of movement behaviour in developmental perspective, this article focuses on children. Therefore, the movement characteristics of three groups of children with psychiatric disorders will be discussed next.

Movement characteristics of children with psychiatric disorders

In line with epidemiological psychiatric research and clinical care programmes three broadly defined categories of psychiatric disorders in children can be distinguished: emotional disorders, behavioural disorders, and autism spectrum disorders (Egger & 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 (Emck, Bosscher, Beek, & Doreleijers, 2009).

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, & Angold, 2003).

The clinical features of mood and anxiety disorders include several body- and movement-related aspects. 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, & Siefen, 2002; Klein, 1994; Sadock & 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 moving and playing (Lamers-Winkelmann, 1997; Sadock & Sadock, 2003). Depression in children is associated with somatic complaints such as abdominal pains, fatigue, reduced ability to experience pleasure,

decreased general activity and psychomotor agitation or retardation (APA, 1994). Moreover, when interacting with other people depressive children express themselves predominantly through nonverbal communication (Harrington, 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, & Spitznagel, 2004).

In contrast, children with *behavioural disorders* are characterized primarily by problems interacting with others, also described as externalizing problems (Achenbach, 1991). Here, the DSM-IV classifications ADHD, oppositional defiant disorder, and conduct disorders are grouped, also in view of the frequent co-occurrence of these disorders.

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 & Norvilitis, 2000). General coordination difficulties and soft neurological signs are frequently reported (Blondis, 1999; Denckla, 2003; Sadock & Sadock, 2003). Finally, about 50% of children with ADHD have comorbid Developmental Coordination Disorder (DCD) (Gillberg et al., 2004; Gillberg & Kadesjö, 2003; Rasmussen & Gillberg, 2000). Fine motor skills such as writing and tying shoelaces are typically the most problematic skills in the latter group (Pitcher, Piek, & Hay, 2003; Whitmont & Clark, 1996). Aendeker and Verheij (1997) suggested that tension, restlessness, psychomotor agitation, and disturbed development of body awareness are often present in children with behavioural disorders. Furthermore, behavioural disorders and emotional disorders are usually intertwined, especially in young children, and it is an issue of debate whether these mixed disorders are characterized by psychomotor agitation (Baker, 1998; Denckla, 2003; Kashani, Heinfichs, Reid, & Huff, 1982; Marmorstein, 2007).

Children with *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). Therefore, this type of disorder counts as a third, separate category.

The movement behaviour of children with ASD is characterized by stereotyped and repetitive motor mannerisms and impairments of facial expression, body postures, and gestures (APA, 1994; Page & Boucher, 1998). Children with autism, a subgroup of children with ASD, exhibit marked obsessive slowing, an increase in posturing, or stereotyped and reduced movement as a forerunner of catatonia (Ghaziuddin, Quinlan, & Ghaziuddin, 2005). Further, children with ASD are often characterized as clumsy and as having problems in motor coordination (Berkeley, Zittel, Pitney, & Nichols, 2001; Ghaziuddin & Butler, 1998; Piek & Dyck, 2004). As many of these children also have learning difficulties, the interpretation of their deficient motor behaviour is complicated. Yet, clumsiness and poor gross motor performance are also mentioned as features of children with Asperger syndrome (Ghaziuddin, Butler, Tsai, & Ghaziuddin, 1994; Ghaziuddin et al., 1992; Manjiviona & Prior, 1995). Hyperactivity is another frequently associated feature; high co-occurrence rates for ADHD are reported: 67.9% for ASD and even 85% for Asperger syndrome (Ghaziuddin, Weidmer-Mikhail, & Ghaziuddin, 1998; Taylor, 1994; Yoshida & Uchiyama, 2004).

Altogether, it is clear that children with emotional, behavioural, and autism spectrum disorders are characterized by distinctive clinical movement features. The question rises if these children also

have impairments in gross motor development, that is: how well do they perform on basic gross motor skills such as running, jumping and throwing balls?

Gross motor performance in children with psychiatric disorders

No one doubts the importance of gross motor skills like running, jumping, throwing, and catching for children participating in games and sports (Dewey et al., 2002; Smyth & 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 et al., 2005, 2007; Schott, Alof, Hultsch, & Meermann, 2007; Wall, 2004).

In a study with 100 child psychiatric participants in the Netherlands we examined which aspects of gross motor performance and physical fitness are affected in children with psychiatric disorders (Emck, Bosscher, van Wieringen, Beek, & Doreleijers, 2011).

Gross motor performance was measured with the Test of Gross Motor Development (TGMD-II) (Ulrich & Sanford, 2000). The test entails two subtests: *locomotion*, concerning 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, 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. Interestingly, the TGMD-II measures the *quality* of the movement pattern, by providing age- and gender dependent criteria for each skill (see Figs. 1 and 2 for the illustration of two locomotor skills and their performance criteria).

Physical fitness was measured by the MOPER (Leyten, Kemper, & Verschuur, 1982) which consists of items that measure different aspects of neuromotor and aerobic fitness. Strength measurements were 'flexed arm hang', 'standing high jump' and 'ten leg lifts'. Speed measurements were 'ten times 5 m sprint' and 'plate tapping'. The flexibility measurement was a 'sit and reach' test. Apart from these neuromotor tasks, aerobic fitness was measured using the 'six-minute run' (Leyten et al., 1982; Runhaar et al., 2010). In contrast with the TGMD-2, the MOPER measures purely quantitative movement aspects such as time in seconds (arm hang) or distance in centimetres (high jump).

Regarding gross motor performance, a developmental delay of approximately three years for both locomotion and object control was found, indicating that the psychiatric group performed significantly worse than typically developing children. Furthermore, children with psychiatric disorders were characterized by very poor neuromotor and aerobic fitness. Although these findings pertained to all subgroups, some remarkable differences were present.

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. Since a neurologically based connection between balance dysfunction and anxiety in children has been documented (Bart et al., 2009; Erez et al., 2004), the variable patterns in gross motor performance in this group might be due to differential effects of balance problems on locomotion and object control.

Although children with *behavioural disorders* performed worse on gross motor skills than those with emotional disorders, this was especially true for the locomotion subdomain. The correlations

(1)



Directions:

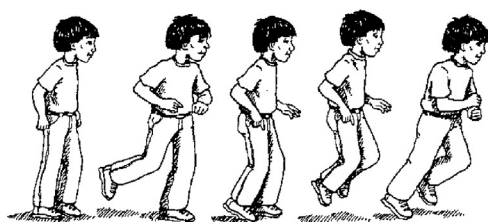
Place two cones 50 feet apart. Make sure there is at least 8 to 10 feet of space beyond the second cone for a safe stopping distance. Tell the child to run as fast as he or she can from one cone to the other when you say "Go".

Repeat a second trial.

Performance criteria:

1. Arms move in opposite to legs, elbows bent
2. Brief period where both feet are off the ground
3. Narrow foot placement landing on heel or to (i.e. not flat footed)
4. Nonsupport leg bent approximately 90 degrees (i.e. close to buttocks)

(2)



Directions:

Mark off a distance of 25 feet with two cones or tape. Tell the child to gallop from one cone to another.

Repeat the second trial by galloping back to the original cone.

Performance criteria:

1. Arms bent and lifted to waist level at takeoff
2. A step forward with the lead foot followed by a step with the training foot to a position of adjacent to or behind the lead foot
3. Brief period where both feet are off the ground
4. Maintains a rhythmic pattern for four consecutive gallops

Figs. 1 and 2. Run and gallop with directions and performance criteria according to the Guide for administering and scoring the TGMD-2 (Ulrich & Sanford, 2000, p. 46).

between locomotion and object control skills were in the normal range. Furthermore, and in line with earlier findings (Harvey & Reid, 2003), both neuromotor and aerobic fitness were clearly impaired in children with behavioural disorders, a fact that is often not acknowledged in clinical practice.

Children with *autism spectrum 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. These results are in agreement with earlier findings indicating abnormally high correlations between ability domains in children with ASD which have been tentatively interpreted as reflecting an underlying impairment in the development of connectivity of brain systems (Belmonte et al., 2004; Dyck, Piek, Hay, Smith, & Hallmayer, 2006).

In addition to the study on gross motor skills and physical fitness, we conducted an experiment concerning the question if gross motor impairment in children with *emotional disorders* might be related to balance problems (Stins, Ledebt, Emck, van Dokkum, & Beek, 2009). 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 that is standing with eyes closed and/or standing on a foam surface. We 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 pattern of

postural sway showed that 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. Keeping in mind that object control was affected more than locomotion in children with emotional disorders, this 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.

Psychiatric symptoms in children with gross motor problems

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 play requiring skills like jumping, running, or throwing balls and that they tend to be physically less fit than typically developing children (Cairney et al., 2005, 2007; Cantell, Crawford & Doyle-Baker, 2007; Emck et al., 2011; Hands & Larkin, 2006). Moreover, gross motor problems are associated with negative self-perceptions (Peens, Pienaar, & Nienaber, 2008; Piek et al., 2006; Poulsen, Ziviani, & Cuskelly, 2006; Skinner & Piek, 2001). While children with gross motor problems are often referred to movement interventions, co-occurring psychiatric problems are seldom taken into account in movement

intervention programs. This might reduce the effectiveness of the programs in improving the broader health status of the children in question.

Hence, we investigated emotional and behavioural problems in a sample of elementary school-aged children who were referred to a movement program by their teachers because of gross motor problems (Emck, Bosscher, Van Wieringen, Doreleijers, & Beek, 2012). We focused on psychiatric disorders and syndromes, social functioning, and self-perceived competence, using parent and self-reports. A high percentage of the children in the sample (65%) met the criteria for at least one psychiatric classification and had significant social impairments. Furthermore, these children perceived themselves incompetent in both the motor and social domain. Anxiety disorders were most prevalent (45%), but also 23% of the children met the criteria for autism spectrum disorders: key symptoms of autism, such as stereotyped behaviour and fear of and resistance to change were abundant. These findings are in line with results of studies indicating that children with poor motor coordination are prone to deficits in social cognition and behaviour (Chen, Tseng, Hu, & Cermak, 2009; Cummins et al., 2005; Dewey et al., 2002; Tseng, Henderson, Chow, & Yao, 2004), and with evidence for a neurobehavioral link between balance and anxiety problems (Stins et al., 2009). Moreover, the findings support the suggestion of a common neurobiological link between motor problems and autism spectrum disorders (Allen, Müller, & Courchesne, 2004; Belmonte et al., 2004; Piek & Dyck, 2004).

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. The combination of motor impairments and emotional, behavioural, or autism spectrum disorders compromises daily living, and high quality prevention and intervention are needed (Kopp, Beckung, & Gillberg, 2009). Since participation in movement activities will become more difficult for these children as they grow older, interventions addressing both physical and psychosocial problems should also start at an early age (Cummins, Piek, & Dyck, 2005; Wall, 2004). By all means, 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 (Emck et al., 2012).

PsyMot: psychomotor diagnosis

In view of the close relationship between psychiatric disorders and gross motor impairments in children, it seems important to complement psychiatric diagnosis with an assessment of movement behaviour. Therefore, we developed the PsyMot, a tool for diagnosis and indications for therapy (Emck, Hammink, & Bosscher, 2007). The aim of the PsyMot differs from the aim of well-known tests of motor performance like the Movement ABC (Henderson & Sugden, 1992) and the TGMD-II (Ulrich & Sanford, 2000). 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 attuned' (Sheets-Johnstone, 2003).

In the assessment procedure, the child is observed in standardized situations and questioned in a semi-structured way about self-perceived motor competence and body-experience (for a short

description see Emck & Bosscher, 2010). In view of the importance and meaning of social bodily play from a neurodevelopmental perspective (Johnson, 2011; Nelson & 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 (see Fig. 3 for an illustration).

In several small studies (Broekman & ten Tusscher, 2008; de Jong & Klinkenberg, 2009; Ritbergen & Coenen, 2010; Sterk, 2011), 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. Currently, different versions are being developed, tested and implemented (for instance: PsyMot-Y for youth, PsyMot-S short version, Portuguese version of the PsyMot, and PsyMot-ID for people with intellectual disabilities, Kay et al., 2014).

Theoretical notions

The findings of the studies described, are in line with current neurodevelopmental theories, which will be addressed in relation to the three main child psychiatric groups mentioned before.

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 & Thayer, 2001; Erez et al., 2004). This nucleus 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 et al., 2009), 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 autism spectrum 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 & Courchesne, 2003; Belmonte et al., 2004). However, this atypicality has been reported for many neurodevelopmental disorders (Diamond, 2000; Piek & 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, & 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 ASD 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).

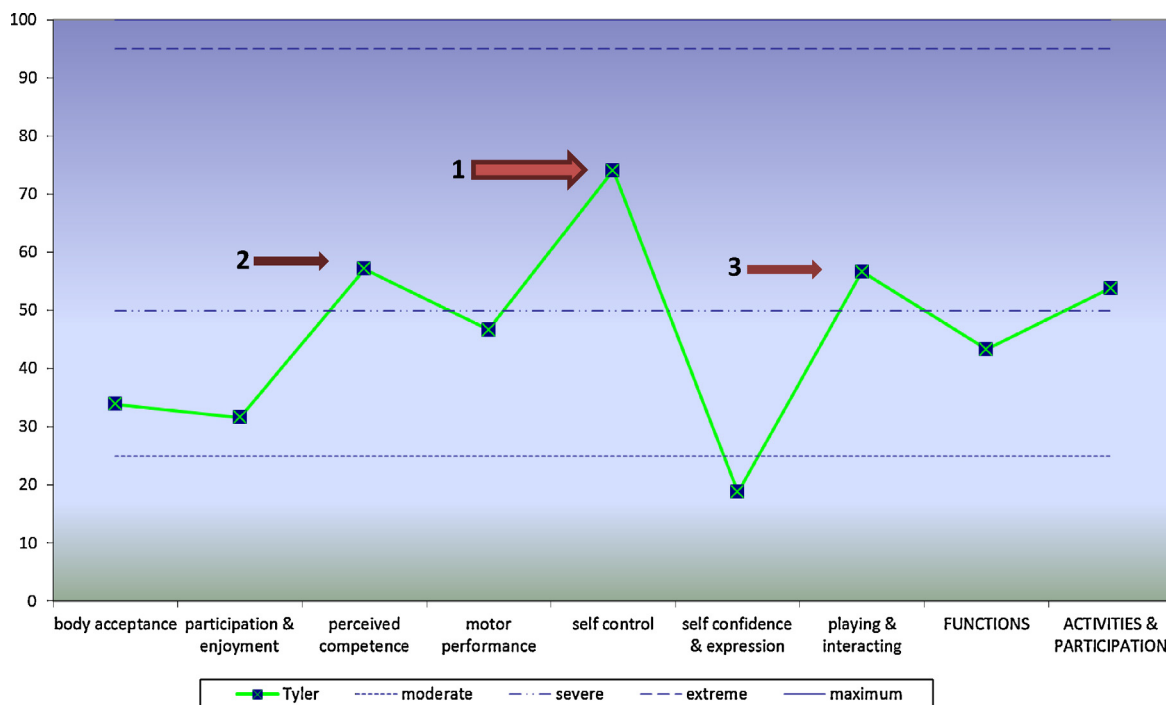


Fig. 3. PsyMot clusters cores for Tyler, a twelve year old boy with Attention Deficit Hyperactive Disorder and associated psychosocial problems. Explanation: since higher scores indicate more problems on a cluster, treatment goals for Tyler should be aimed at improving (1) self-control, preferably combined with (2) self-perceived physical and motor competence and (3) social play behaviour.

These considerations are reinforced by our studies which not only showed severe gross motor problems in children with autism spectrum disorders, but also that children selected on the basis of poor gross motor performance showed a high prevalence of symptoms of autism. Thus, we agree with the suggestion of [Allen et al. \(2004\)](#), [Belmonte et al. \(2004\)](#) and [Piek & Dyck \(2004\)](#) that cerebellar dysfunction constitutes a common neurobiological link between motor problems and ASD.

However, the cerebellum is not the only brain structure involved in ASD. 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 & Belmonte, 2005](#); [Belmonte et al., 2004](#)). According to [Mostofsky, Burgess, & 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 we found in children with ASD, which is in agreement with the conclusion of [Dyck et al. \(2006\)](#) that ability domains in ASD 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 ([Belmonte et al., 2004](#)).

Third, the findings in children with behavioural problems are of interest. According to [Krain and Castellanos \(2006\)](#), 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 ASD, the significantly lower correlation between locomotion and object control scores in children with ADHD 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 & Healy \(2011\)](#). 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 enhancing cognitive and behavioural development, and neural growth ([Halperin & Healy, 2011](#)).

Finally, it is important to realize that the neurobiological account of the relationships between psychiatric disorders and movement behaviour does not preclude the role of psychosocial and environmental factors. In particular, as has been suggested by [Cairney \(2011\)](#), 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, Hay, Veldhuizen, Missiuna, & Faught, 2010](#); [Cairney, Veldhuizen, & Szatmari, 2010](#)). Moreover, many genetic, biological and environmental interactions are still unknown. The influence of powerful environmental factors on brain development and functioning is increasingly recognized with respect to ADHD ([Halperin & Healy, 2011](#); [Sonuga-Barke & 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 & Healy \(2011\)](#) proposed directed play and physical exercise as a means to promote brain growth and influence the underlying neural determinants of ADHD. Therefore, the acknowledgement of a complex interplay between environmental factors and neurodevelopmental processes is of outstanding importance for the development of diagnostic tools as well as for interventions.

Clinical implications

Given the results of our studies, and in line with neurodevelopmental perspectives a broad assessment of movement behaviour

– including interactional and expressive aspects, self-appraisal and body experience – is recommended as an integral part of the diagnostic procedure in child psychiatry (Cairney, Missiuna, Veldhuizen, & Wilson, 2008; Gillberg, 2010; Emck et al., 2011). It is also recommended that children with motor problems are screened for psychosocial problems and psychiatric symptoms, also because motor problems may be predictive for anxiety disorders (Piek, Barrett, Smith, Rigoli, & Gason, 2010) and schizophrenic disorders (Erlenmeyer-Kimling et al., 2000).

Most important, dance/movement therapy should be part of the standard treatment for children with neurodevelopmental disorders and psychiatric symptoms. The interconnections and interactions between psychiatric problems and movement behaviour which are addressed in dance/movement therapy, as well as theoretical accounts of their relationship, support its use in child psychiatric practice. Thereby, it is essential to tailor the intervention to the specific needs of the child and to focus on strengthening the child's self-concept (Dewey & Wilson, 2001; Peens et al., 2008). As stated before, treatment goals for dance/movement therapy range from experiential, to behavioural and social, and – according to the PsyMot procedure – they may concern body acceptance, participation and enjoyment, perceived physical and motor competence, motor performance, self-control, self-confidence and self-expression and, playing and interacting with peers. By using mirror-movements, a keystone of the therapeutic process of dance/movement therapy (Berrol, 2006, p. 303), one can address all of the above mentioned treatment goals if required. Moreover, the development of kinaesthetic attunement, which is of great importance for psychosocial and moral development, is specifically emphasized and stimulated by moving together (Loman & Merman, 1996; Sheets-Johnstone, 2003, 2010). In line with these notions, Erfer (2006) described the use of mirroring in a group setting for children with emotional and behavioural disorders to improve the development of body image and self-awareness, successively improving the awareness of others. More recently, Samaritter & Payne (2012) proposed a 'shared movement approach' in dance/movement therapy for children with autism spectrum disorders (ASD), in order to bring about relational movement experiences to increase a better sense of self. Since ASD seems to be characterized by lack of embodiment, not only teaching motor skills is supposed to be beneficial, but also eliciting facial expressions or body postures in children may help explicitly to 'entrain' the body with embodiment (Eigsti, 2013). Thus, dance/movement therapy can offer distinct bodily experiences that unmistakable are of great worth for children with developmental challenges.

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 Cortese, 2013; Eigsti, 2013; Halperin & Healy, 2011; Rommel, Halperin, Mill, Asherson, & Kuntsi, 2013). In this regard, the advice of Rutter et al. (2004) is also noteworthy: "If a particular therapy is envisaged, assessment in that mode is usually indicated" (p. 30). It follows that children who come to the attention of a child psychiatric service deserve standard assessment of movement behaviour, regardless of the type of psychiatric symptoms they present. 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. Movement assessment at an early stage may not only prevent these additional problems, but may also serve to offer promising dance/movement interventions that enhance brain development. Consequently, movement assessment should be aimed at indicating children for dance/movement interventions with clearly formulated treatment goals.

Acknowledgements

I am grateful for the support I received from Prof. Dr. Theo Doreleijers, Prof. Dr. Peter Beek, Dr. Piet van Wieringen, Dr. Ruud Bosscher during my PhD research on which this article is based.

References

- Achenbach, T. M. (1991). *Manual for the Child Behavior Checklist/4-18 and 1991 Profile*. Burlington, VT: University of Vermont.
- Aendekerker, 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.
- Baker, E. D. (1998). Mixed disorder of affective and disruptive behaviors in hospitalized adolescents. A structural equations modeling approach. *Dissertation Abstracts International*, *58*, 4435.
- Balaban, C. D., & Thayer, J. F. (2001). Neurological bases for balance-anxiety links. *Journal of Anxiety Disorders*, *15*, 53–79.
- 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.
- 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.
- 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. *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.
- Berrol, C. F. (2006). Neuroscience meets dance/movement therapy: Mirror neurons, the therapeutic process and empathy. *The Arts in Psychotherapy*, *33*, 302–315.
- 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.
- Broekman, H., & ten Tusscher, M. (2008). *The PsyMot. An investigation of the reliability by using new and specific measures* (Master thesis). Amsterdam: VU University.
- Buytendijk, F. J. J. (1948/1963). *(General theory of human posture and movement) Algemene theorie der menselijke houding en beweging*. Utrecht: Het Spectrum.
- Cairney, J. (2011). Gross motor problems and psychiatric disorders in children. *Developmental Medicine and Child Neurology*, *53*, 104–105.
- Cairney, J., Hay, J. A., Faight, B. E., Wade, T. J., Corna, L., & Flouris, A. (2005). Developmental coordination disorder, generalized self-efficacy toward physical activity, and participation in organized and free play activities. *Journal of Pediatrics*, *147*, 515–520.
- Cairney, J., Hay, J. A., Mandigo, J., Wade, T., Faight, 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., Missiuna, C., Veldhuizen, S., & Wilson, B. (2008). Evaluation of the psychometric properties of the developmental coordination disorder questionnaire for parents (DCDQ): Results from a community based study of school-aged children. *Human Movement Science*, *27*, 932–940.
- Cairney, J., Hay, J. A., Veldhuizen, S., Missiuna, C., & Faight, 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., 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.
- 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.
- Cortese, S. (2013). Gym for the attention-deficit/hyperactivity disorder brain? Still a long run ahead. ... *Journal of the American Academy of Child and Adolescent Psychiatry*, *52*, 894–896.
- 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.

- Cruz, R. F., & Berrol, C. F. (2004). *Dance/movement therapists in action. A working guide to research options*. Springfield, IL: Charles C. Thomas.
- Cummins, A., Piek, J. P., & Dyck, M. J. (2005). Motor coordination, empathy, and social behaviour in school-aged children. *Developmental Medicine and Child Neurology*, 47, 437–442.
- 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.
- de Jong, Y., & Klinkenberg, M. (2009). *Reliability of the PsyMot in trained therapists (Master thesis)*. Amsterdam: VU University.
- Denckla, M. B. (2003). ADHD. Topic update. *Brain Development*, 25, 383–389.
- Dewey, D., & Wilson, B. N. (2001). Developmental coordination disorder: what is it? *Physical and Occupational Therapy in Pediatrics*, 20, 5–27.
- 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.
- Diamond, A. (2000). Close interrelation of motor development and cognitive development and of the cerebellum and prefrontal cortex. *Child Development*, 71, 44–56.
- Dyck, M., 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.
- Eigsti, I. (2013). A review of embodiment in autism spectrum disorders. *Frontiers in Psychology*, 4(24), 1–10.
- Emck, C., & Bosscher, R. J. (2010). PsyMot: An instrument for psychomotor diagnosis and indications for psychomotor therapy in child psychiatry. *Body, Movement and Dance in Psychotherapy*, 5, 244–256.
- Emck, C., Hammink, M. N., & Bosscher, R. J. (2007). (PsyMot: Psychomotor diagnosis and treatment indications for children aged six to twelve years) *PsyMot: Psychomotorische diagnostiek en indicatiestelling voor kinderen van 6 tot 12 jaar*. Utrecht, the Netherlands: 't Web.
- 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 and 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 and Child Neurology*, 53, 150–156.
- Emck, C., Bosscher, R. J., Van Wieringen, P. C. W., Doreleijers, Th., & Beek, P. J. (2012). Psychiatric symptoms in children with gross motor problems. *Adapted Physical Activity Quarterly*, 29, 161–178.
- 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., et al. (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.
- Fliers, E., Vermeulen, S., Rijdsdijk, F., Altiink, 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.
- Ghaziuddin, M., & Butler, E. (1998). Clumsiness in autism and Asperger syndrome. A further report. *Journal of Intellectual Disability Research*, 42, 43–48.
- 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., Butler, E., Tsai, L., & Ghaziuddin, N. (1994). Is clumsiness a marker for Asperger syndrome? *Journal of Intellectual Disability Research*, 38, 519–527.
- Ghaziuddin, M., Weidmer-Mikhail, E., & Ghaziuddin, N. (1998). Comorbidity of Asperger syndrome. A preliminary report. *Journal of Intellectual Disability Research*, 42, 279–283.
- Ghaziuddin, M., Quinlan, P., & Ghaziuddin, N. (2005). Catatonia in autism. A distinct subtype? *Journal of Intellectual Disability Research*, 49, 102–105.
- Gibson, E. J. (1988). Exploratory behaviour in the development of perceiving, acting and the acquiring of knowledge. *Annual Review of Psychology*, 39, 1–41.
- Gillberg, C. (2010). The ESSENCE in child psychiatry: Early symptomatic syndromes eliciting neurodevelopmental clinical examinations. *Research in Developmental Disabilities*, <http://dx.doi.org/10.1016/j.ridd.2010.06002>
- Gillberg, C., & Kadesjö, B. (2003). Why bother about clumsiness? The implication of having developmental coordination disorder (DCD). *Neural Plasticity*, 10, 59–68.
- Gillberg, C., Gillberg, I. C., Rasmussen, P., Kadesjö, B., Söderström, H., Rasatam, M., et al. (2004). Co-existing disorders in ADHD. Implications for diagnosis and intervention. *European Child and Adolescent Psychiatry*, 13(Suppl.), 180–192.
- Halperin, J. M., & Healy, D. M. (2011). 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*, 35, 621–634.
- 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.
- 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.
- Henderson, S. E., & Sugden, D. A. (1992). *Movement Assessment Battery for Children*. London: The Psychological Corporation.
- Johnson, M. H. (2011). *Developmental cognitive neuroscience*. Chichester, UK: John Wiley & Sons.
- Kashani, J. H., Heinfichs, T. F., Reid, J. C., & Huff, C. (1982). Depression in diagnostic subtypes of delinquent boys. *Adolescence*, 17, 943–949.
- Kay, J., Clegg, J. A., Emck, C., & Standen, P. J. (2014). PsyMot (ID): A diagnostic tool to direct body-mind physiotherapy for people with ID in acute mental health services. Manuscript submitted for publication.
- Kiphard, E. J., & Schilling, F. (1970). Die Hamm-Marburger Körperkoordinationstest für Kinder (HMKT) [Hamm-Marburger body coordination test for children]. *Monatsschrift 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.
- 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*, <http://dx.doi.org/10.1016/j.ridd.2009.09.017>
- Krain, A. L., & Castellanos, F. X. (2006). Brain development and ADHD. *Clinical Psychology Review*, 26, 433–444.
- Lamers-Winkelmann, 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.
- Leyten, C., Kemper, H., & Verschuur, R. (1982). (The MOPER fitness test. Manual and performance scales 9 to 11 year olds) *De MOPER fitheidstest. Handleiding en prestatieschalen 9 t/m 11 jarigen*. Haarlem, the Netherlands: De Vrieseborch.
- Loman, S., & Merman, H. (1996). The KMP: A tool for dance/movement therapy. *American Journal of Dance Therapy*, 18, 29–52.
- 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.
- 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.
- Merleau-Ponty, M. (1945). (The phenomenology of perception) *Phénoménologie de la perception*. Paris: Gallimard.
- 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.
- Nelson, C. A., & Luciana, M. (2008). *Handbook of developmental cognitive neuroscience*. Cambridge, MA: MIT Press.
- Ozonoff, S., Young, G. S., Goldring, S., Greiss-Hess, L., Herrera, A. H., Steele, J. S., et al. (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 and Therapy*, 14, 233–259.
- Payne, H. (2006). *Dance movement therapy. Theory research and practice* (2nd ed.). London: Routledge.
- 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.
- Piaget, J. (1952). *The origins of intelligence in children*. New York: International Universities Press.
- 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., 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., 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.
- Pitcher, T. M., Piek, J. P., & Hay, D. A. (2003). Fine and gross motor ability in males with ADHD. *Developmental Medicine and 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.
- Probst, M., & Bosscher, R. J. (2001). (Developments in psychomotor therapy) *Ontwikkelingen in de psychomotorische therapie*. 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.
- 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.
- Ritbergen, B., & Coenen, C. (2010). (The interrater reliability of the PsyMot in youngsters with intellectual disabilities) *De interbeoordelaarsbetrouwbaarheid van de PsyMot bij licht verstandelijk beperkte jongeren*. Zwolle, the Netherlands: Windesheim University of Applied Sciences.
- Röhrich, 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.
- Röhrich, F., & Priebe, S. (2006). Effect of body-oriented psychological therapy on negative symptoms in schizophrenia: A randomized controlled trial. *Psychological Medicine*, 36, 669–678.
- Rommel, A., Halperin, J. M., Mill, J., Asherson, P., & Kuntsi, J. (2013). Protection from genetic diathesis in attention-deficit/hyperactivity disorder: Possible complementary roles of exercise. *Journal of the American Academy of Child and Adolescent Psychiatry*, 52, 900–910.
- 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.
- 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. (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.
- Samaritser, R., & Payne, H. (2012). Kinaesthetic intersubjectivity: A dance informed contribution to self-other relatedness and shared experience in non-verbal psychotherapy with an example from autism. *The Arts in Psychotherapy*, 40, 143–150.
- Schott, N., Alof, V., Hulst, 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.
- Sheets-Johnstone, M. (2010). Why is movement therapeutic? *American Journal of Dance Therapy*, 32, 2–15.
- Simons, J., Van Coppenolle, H., Pierloot, R., & Wauters, M. (1989). Zielgerichte Beobachtung des Begegnungsverhältnis in der Psychiatrie [Goal related observation of motor behavior in psychiatry]. *Rehabilitation*, 28, 117–122.
- Skinner, R. A., & Piek, J. P. (2001). Psychosocial implications of poor motor coordination in children and adolescents. *Human Movement Science*, 20, 73–94.
- 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.
- Sterk, M. (2011). *Concurrent validity and internal consistency of the PsyMot* (Master thesis). Amsterdam: VU University.
- 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. www.behavioralandbrainfunctions
- 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.
- 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.
- Ulrich, D. A., & Sanford, C. B. (2000). *Test of Gross Motor Development* (2nd ed.). Austin, TX: Proed.
- van Roozendaal, N. P. (1957). A method of movement-analysis with psychiatric patients. *Folia Psychiatrica, Neurologica et Neurochirurgica, Neerlandica*, 57, 356–366.
- van Roozendaal, N. P. (1973). (A method of movement observation in mental health institutions) *Een methode van bewegingsonderzoek in de psychiatrische inrichting*. Zeist, the Netherlands: Jan Luiting Fonds.
- 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 life span* (pp. 191–215). Amsterdam, the Netherlands: VU University Press.
- 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.
- 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.
- Wing, L. (1981). Asperger's syndrome: A clinical account. *Psychological Medicine*, 11, 115–129.
- 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.
- 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.