

Movement quality in children with developmental delay: Midline and weight sensing as markers of adaptive movement

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Abstract

Motor assessment is an important tool in diagnosis and intervention for children. Ideally, the lens used in assessment is based on a dynamic, developmental paradigm that supports functional adaptability. The main purpose of this paper is to describe challenges of movement assessment in children under 5 years of age who have developmental delays. Key issues in motor development using qualitative, developmental descriptors stemming from the fields of dance and movement contribute to a motor observation tool under development. We observed 20 children during motor assessments and play sessions at a hospital clinic. We found that the children with developmental delays were compromised in their midline organization and their ability to move in relationship to gravity. A multi-level approach to movement assessment and treatment is recommended for children with developmental delays. The basic concepts of midline and weight sensing are essential in dance/movement-based supervision, and for our personal growth as movers.

Keywords: *Movement development, assessment, observation, adaptation*

Introduction

The main purpose of this paper is to describe challenges of movement assessment in children under the age of 5 years old with typical and atypical motor development. The impetus for our study comes from clinical

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practitioners and parents who have expressed frustration with the limitations of conventional, standardized motor assessment. Although these assessments are based on relatively large samples of typically developing children, the interviewed parents and practitioners in North America and Europe repeatedly mentioned that the linear motor development model, in the background of most motor tests, and the task completion focus of these instruments, can impede early diagnosis and intervention. *How* children were moving was not adequately addressed in the existing assessment protocols. Appropriate recognition of atypical motor development is necessary for referral to early intervention services, which can help these children to overcome or improve motor function, as well as to help families grow more confident in caring for children with special needs (Edwards & Sarwark, 2005).

A neuro-developmental research perspective supports the inclusion of a qualitative lens in motor assessment. Clinical follow-up studies of preterm born infants until toddler and school age have reported that low-risk preterm born infants may have atypical postural behavior in terms of reduced amount of rotation during crawling, delayed dynamic balance, and delayed onset of and a poor quality of early walking behavior. At school age, dysfunctions such as problems in standing on one leg and poor hopping are reported. Neuro-physiological data of postural control at early age can indicate the presence of a dysfunction in the capacity to modulate postural activity, and the postural activity has been characterized by temporal disorganization of electro-myographic (EMG) responses. Postural responses to goal-directed reaching in supine lying have been recorded and analysed in terms of the total body center of pressure (Fallang & Hadders-Algra, 2005). Further, infants with Developmental Coordination Disorder (DCD) (American Psychiatric Association, 1994) and Cerebral Palsy (CP) tend to show less mobile postural behavior compared with age typically developing infants (Williams, 2002). The problems in the adaptation of the degree of muscle contraction might be the reason why children with CP, more often than typically developing children, show an excess of antagonistic co-activation during difficult balancing tasks. The stereotypic movement patterns in CP might be regarded as functional strategies to compensate for the dysfunctional capacity to modulate subtle postural activity (Van der Heide & Hadders-Algra, 2005).

In a study by Bockowski, Sobaniec, Kulak, & Smigielska-Kuzia (2005), evoked potentials were recorded in 5 to 16 year old children with clumsiness, or DCD, to evaluate the integrity of the afferent pathways and to rule out the presence of any neurological lesions. There was a relationship among perceptual-motor skills, cognitive impairment, and electrophysiological findings in children with DCD. The disturbances of the integrity of the afferent pathways were suggested as one of the many causal factors for motor problems. Further research is required to determine if a neurological deficit can explain clumsiness in children. That information might also decrease the variable terminology used in different studies (for review see Cermak, Gubbay, & Larkin, 2002; Wilson, 2005). To name a few, these children have also been described as having movement clumsiness, motor difficulties,

motor learning problems (Hands & Larkin, 2001), dyspraxia (Ayers, 1991), minor cerebral palsy (Blondis, 1996, 2004) or minor neurological dysfunction (Hadders-Algra, 1993).

Children who have been diagnosed with a developmental disorder are very likely to meet diagnostic criteria for some other developmental disorder (Cantell, Smyth, & Ahonen, 1994, 2003). Although co-occurrence has long been acknowledged in childhood disorders, little is understood about the mechanisms that are responsible for it (Kaplan, Wilson, Dewey, & Crawford, 1998). Poor sensory-motor integration has been implicated as a cause of motor problems in developmental disorders such as DCD. Piek and Dyck (2004) investigated the link between sensory-motor deficits and developmental disorders, attention deficit hyperactivity disorder (ADHD), and autistic disorder. They argue that the importance of poor sensory-motor functioning in discriminating children with different disorders has been underestimated. Interestingly, Piek and Dyck suggest that sensory-motor deficits in children with DCD and autistic disorder may provide insight into some of the social difficulties found in these groups of children.

Pediatricians are often called on to prescribe physical, occupational, and speech-language therapy services for children with motor disabilities (Michaud, 2005). Also, identifying infant and child developmental delay is a skill important for orthopedic surgeons to master because they often are asked to distinguish between normal and abnormal movement. Clinical research in neurology and neuropsychology suggest, however, that the early neurological signs associated with atypical motor development, such as in CP, may not be sensitive enough by themselves to apply the diagnosis of CP (Nelson & Ellenberg, 1982). Furthermore, there are several valid tools for measuring the level of neurodevelopmental maturity of children, but their diagnostic usefulness is questioned (Blondis, Snow, & Accardo, 1990; Roy, Bottos, Pryde, & Dewey, 2004). Examination of the reliability and validity of various sensory and motor soft signs measures has also produced mixed results. Roy et al. (2004) suggest that the most reliable tests seem to be those assessed on continuous scales, such as the time needed for certain number of repetitive movements.

To address the poor sensitivity and specificity of quantitative infant neurological assessments, new methods that emphasize qualitative assessment have been developed. As an example, researchers in Switzerland, Italy, and the Netherlands have developed a qualitative observation of spontaneous motility of preterm and term infants (Cioni, Ferrari, Einspieler, Paolicelli, Barbani, & Prechtl, 1997; Hadders-Algra, 1993; Hadders-Algra, Mavinkurve-Groothuis, Groen, Stremmelaar, Martijn, & Butcher, 2004; Prechtl, 1990; Prechtl & Franzens, 2001). They assess quality of movements on a global judgment of normal versus abnormal quality. The term general movements (GMs) was given to movements that involve the whole body and last from a few seconds to several minutes. The GMs of abnormally developing infants tend to lack complexity; they are slow and monotonous or chaotic, with unexpected reductions in subtle fluctuations or force, amplitude, and speed. Abnormal GMs may also appear rigid and lacking

in smooth and fluent character. It has been found that the GMs are better at predicting neurological outcome at 2 years of age than traditional neurological examination (Cioni, Prechtl, Ferrari, Paolicelli, Einspieler, & Roversi, 1997). Clearly, qualitative movement assessment may be a more sensitive indicator of developmental delays. In the dance movement therapy field, several tools such as the Kestenberg Movement Profile (KMP) (Kestenberg, 1975; Loman, 1995) and Laban Movement Analysis (LMA) (Bartenieff, Davis, & Paulay, 1970; Laban, 1960) have been developed for systematic movement observation. The movement observation tools from different fields, however, are not well-known outside their original fields which are restricting the possibility of combining different knowledge bases. Thus, the long-term goal of the research project described in this paper is to find a qualitative, and yet quantifiable, observation method that combines language used in mainstream healthcare, developmental movement, and dance movement therapy. In this article we concentrate on describing the challenges of a qualitative assessment of fundamental movement patterns in children under the age of 5 years old with typical and atypical motor development.

Methodology

Based on Cruz and Koch (2004, p. 47), our research approach can be described as unstructured (meaning that observation is done without explicit predefined categories), non-participatory, overt (indicating that observed persons know that they are observed), mediated by technical means (i.e., videotaped) field study (taking place in a natural setting). During the process of developing an interdisciplinary motor observation tool, we need to discuss some key issues in motor development using qualitative, developmental descriptors stemming from the fields of dance and movement. We are aware of the need of clarity in terminology and try to combine research from dance movement therapy, developmental movement, Body-Mind Centering[®] (BMC) and artistic inquiry with different disciplines such as neuroscience, neurology, and neuropsychology. While concentrating on the process of observation, we journey through our own bodies and search for terminology that describes what we are seeing. We thus take a personal and subjective perspective, recognizing that it is not commonly utilized, and often also not accepted, in motor assessments in the mainstream healthcare.

After the ethical approval of the study from the Office of Medical Bioethics, University of Calgary, we introduced our general tool idea to the staff of a child development clinic. The staff chose 20 children for the study who had been referred for motor assessments due to their developmental delays; some of them were diagnosed with DCD or CP, while some others were in the process of being diagnosed. We had a non-participatory role in the actual assessments, we observed and videotaped the children during their assessments and group play sessions, and tried to understand the children's movement and their message. We intentionally remained uninformed about the children's diagnoses, as we wanted to be able to observe without preset

expectations. Staff was offered an option to observe the videotapes after each session and during their own time.

Data analysis can, in this context, be seen as kinesthetic attunement and kinesthetic empathy (Lewis, 1984), reflection, and mirroring. This is typical of artistic inquiry methodology as described by McNiff (1987, 1998), Meekums (1996), and Hervey (2000, 2004). We explored the child's movement in kinesthetic, emotional, and intuitive ways. We could not always articulate our embodied experience in words although we felt it deeply and tacitly in our bodies. Children's movements revealed unconscious material in us, and we allowed somatic countertransference to become part of our research data (Cantell & McGehee, 2005; McGehee, 2006).

Findings

In this paper we describe our preliminary findings that include a description of our experience of observation, as well as the latent variables that are included in our movement observation tool under development. What seemed intriguing for us during the observation of the children with developmental delays was the atypical kind of fluency and flow in the movement quality. The more we observed, the stronger the sensation of "stuckness" in our bodies became. We became interested in the developmental markers that impacted this experience. We were looking for descriptive vocabulary that would convey both what we witnessed and how it impacted our observing bodies. During observation, it also seemed necessary to differentiate the child from the clinical assessment context and to do the same while observing, i.e., to sense our wholeness to narrow the focus of seeing, as well as to re-integrate that perspective into the big picture. In a dance movement therapy context, this observational process relates to observing with a feeling body, or kinesthetic attunement (Hervey, 2000, 2004; Lewis, 1984). In BMC, this would be described as meeting the children where they are (Bainbridge-Cohen, 1993).

Approaching from presence: The relationship of the parts to the whole

In education, assessment, and intervention, a focus on sophistication, objectivity, and professionalism takes us to greater levels of specificity. Dealing with the body in clinical practice, elite training, and artistic endeavors, we forget the importance of support and re-integrating learned specificity. Without "the whole," the differentiated experience suffers. With ongoing disengagement toward further specificity, the organism suffers.

Re-integration is thus an intrinsic part of development and healing. The richness of the whole is reflected in the microcosm of cellular experience and the interdependency of systems that dynamically weave to give life to the multifaceted organism. As we grow and change we preserve both integrity and connection. Communication and re-integration following differentiation is a key to smooth functioning. Where wholeness is interrupted, a relationship

of support can engage and elicit a more primary wholeness intrinsic to an organism's health and development. The well body does this naturally with cycles and phrasing that support our needs. We move through cycles of differentiation and re-integration. Where we have missed out on the primary expression of developmental movement patterns and reflexes or where the systems become taxed and disconnected from these earlier patterns, we can return to these fundamentals to re-establish holism and adaptive ability (Bainbridge-Cohen, 1993).

In early development, the expression of the body's rhythms is melded to the environment through a relationship to gravity and the container of the womb. Here motility and mobility co-exist. Relationship engenders reflexive reactions to the environment: moving toward and away, bonding and defending. The early matrix of a fluid, adaptive, vital self ensures our survival throughout life. Adaptation is expressed in movement; a balance that is struck in the relationship between self and environment, much like inner homeostasis. Our bodies expertly track, measure, and execute these changes on safe continuums that are expressly concerned with the quality of life. Bainbridge-Cohen (1993) has postulated that each reflex has a modulating reflex. These act as the templates for volitional integrated movement. Volitional movements are enhanced by experience and coordinated appropriately. Balanced responsiveness is the product of an expanded ability to modulate movement and therefore behavioral choices.

Latent variables: Relationship to gravity and midline organization

As we observed children in our study, latent movement variables emerged from our qualitative evaluations (Cantell & McGehee, 2005; Cantell, McGehee, & Eddy, 2004; McGehee, in press). These variables seemed to have such an underlying and foundational role in movement development, and yet they were not measured or described in the vocabulary of standardized testing. We looked at these variables in our own language and attempted to find appropriate vocabulary to communicate them effectively across disciplines. We realized that assessment, education, and intervention protocols often did not show consideration for the developmental paradigm that foundational stages of movement development underlie and support more sophisticated activity throughout our lives. Furthermore, we realized that as most of the movement assessment protocols are based on a linear developmental model, it is not typical to believe that fundamental movement repertoire can be evoked and enhanced at any developmental stage.

The latent movement variables we examined had to do with a fundamental relationship to gravity and midline organization that are both markers of health in early infancy (Blondis, 2004; Teitelbaum et al., 2004). These variables play an important role in early sensory motor integration (Ayres, 1991; Bainbridge-Cohen, 1993). We saw how necessary these fundamentals are to movement, psychological, and behavioral adaptation. They are fundamental to all transitions in time and space and inherent to growth and development. They are the support for balancing inside and outside

awareness. A qualitative lens allowed the emergence of this dependency from the video data. A quantitative observation based on task completion did not. Fundamental adaptation, the ability to adapt and make choices from a large movement repertoire, lends dynamic control to movement and behavior.

Moving around an axis creates the foundation for three dimensional movement in three dimensional space. In BMC vocabulary, early midline organization is reflected in the autonomic nervous system rhythm that balances parasympathetic and sympathetic responses. This postulated rhythm suggests that parasympathetic and sympathetic states are on a flow continuum. The continuum is a useful model for responsiveness. This movement template develops in concert with a relationship to gravity. The concept of inner and outer attention and action therefore has a clear relationship to movement in time and space even in early stages of responsiveness. In this model, this early neuro-physiological balancing act underlies subsequent reflexive movements that occur in the spine and limbs as flexion, adduction, and inward rotation or extension, abduction, and outward rotation. Early nervous system responses also stimulate tonus, as do early environmental stimulus in how we are carried, placed, and what tone our caregivers communicate in. Touch and vestibular responsiveness are the first means of communication. Tone can be seen as psychophysical phenomena. Whole body responsiveness is a necessary support to development of stability and mobility, sequencing, and specificity of movement. This “gestalt” underlies a sense of a self, acting relationally in the world (Ayers, 1991, p. 61–70; McGehee, 2003).

Observing the midline organization in children is important for many reasons. As a baby begins to measure inner and outer experience through responsiveness and reflexive adaptation, the limbs connect to a central axis and a gravitational center. Lack of primary integration taxes the organism and leads to maladaptive habitual responses. The articulation of the spine on three planes underlies the ability to support core distal connectivity in locomotion. Motor development occurs first in the spine, followed by the upper extremities, followed by the legs. Uneven spinal tonus, such as too much extensor tone in relation to flexor tone, or a lack of experience of all sides of the body, interrupts the subsequent support and development of limb co-ordination. Children learn sequencing and control by playing off balance, and coming back to balance. Measuring and grading along a continuum is a sign of maturation. Midline organization is linked via sensory awareness to social contact. It allows a perceptual motor link necessary to survival, adaptation, and learning. It emerges with the manifestation of social smile and social engagement. Any measurement of midline must acknowledge it as a rich composite of developmental events (Bainbridge-Cohen, 1993, p. 141–156; McGehee, 2003).

We could not observe midline as a structural place. Often we saw children who could cross midline with their limbs, but whose torsos were unresponsive. Midline seemed to require the three-dimensional, dynamic equilibrium, whole-body fluid rhythm of organization around a central axis.

This is measured in infancy as the tone of physiological flexion and extension. Children born without sufficient flexor tone often develop higher than normal extensor tone (Ayres, 1991). This makes the early midline reflexes (such as oral rooting and Babkin) and later volitional movements on the transverse and frontal planes more difficult.

Recognizing responsiveness and adaptability as important allowed us to see that perceptual motor organization at different levels in space varied. The children we observed showed us where the midline organization broke down and where perceptual motor connections were weak. They expressed at what level in space they felt supported and responsive in unstructured moments but were often tested beyond their level of comfortable organization.

Developing support for movement along a continuum of space, time, and quality is important to adaptive responsiveness. In BMC, the ability to actively release weight or yield into support as witnessed in a healthy tonic labyrinthine response is a pre-cursor to pushing. We fall to rise. The act of yielding sets up the body's vestibular and proprioceptive responses to modulate an efficient volitional push, or weight shift (Ayres, 1991, p. 79–84). In a sense, we maintain neuroplasticity by modulating movement with gravitational support. We sense our weight in order to move our weight. This relates to the dance movement therapy term “grounding,” simply meaning contact with the ground. It has been found that asymmetry and atypical reflexes, such as failing to keep the head vertical during tilting at 6 months of age, can be predictive of later diagnosis of autism and Asperger Syndrome (Teitelbaum et al., 2004).

Interestingly, Meekums (2002) has described grounding as “an ability to perceive and live in the here and now” (p. 64), as well as “a process of making real, of embodying the insights gained in the previous stage” (p. 21). A child who has an ability to sway and rebound has a responsive relationship between his (body) weight and gravity. When a child is comfortable with the element of yield, he seems to be molding into the supporting surface. This is fundamentally important, as molding is one of the key concepts in a therapeutic relationship, indicating that the body shapes (in this case of the child and the adult) fit into and around each other.

During unstructured moments of assessment and play, the children we observed, and often also their caregivers, demonstrated they were seeking the resilience of yield. Children were responsive to tone changes in adults. Facilitation of weight shift through the pelvis and spine on the floor brought out greater core connection. Encouraging comfort rather than tension and following a child's improvisational interests heightened attention and intention. Falling safely, rather than being upright or straight, heightened movement co-ordination. Assisting the children to explore level change in space from the ground up encouraged sensory motor integration and confidence.

Our observations brought us to acknowledge that the ability to relax actively into a supporting surface underlies locomotion at any age. In typical development, sufficient flexor tonus supports the emergence of cervical and

lumbar curves and the core support to initiate and respond to weight shift. Feeling support and connectivity enhances adaptation and learning.

Conclusion

The children we observed with developmental delays were compromised in their midline organization and their ability to mold and move in relationship to gravity, particularly in bipedal postures and transitions. The fluid support of a whole-body midline responsiveness lends support and resilience to motor movements. The ability to actively release into support to locomote through space lends control and versatility to movement and behavioral transitions. These relational acts support development. They are measurements of healthy tone and responsiveness in all the anatomical systems and fundamental to the re-integration of learned activities (McGehee, 2004).

In the moments after birth we traditionally measure the infants breathing, heart rate, color, tone, and response through an Apgar evaluation (Hogan & Ryan, 1977; Pearce, 2005; Schmidt, Kirpalani, Rosenbaum, & Cadman, 1988). We continue to measure heart rate, breathing, and color throughout life. We seem to disregard, however, the relevance of tone and responsiveness quite soon after birth.

Social development is linked to functional motor adaptability. It involves a complex understanding of actions in time and space. “Fixing” in the sensory and motor systems indicates a lack of support for efficient function. The seeds of social/emotional development are sown before we learn to locomote. They emerge with core reflexes in responses to stimuli. We learn to move in a social emotional context supported by this ground, this home, this holism. In training to become more objective and specialized, we as observers are also leaving behind the support necessary to observe. Through attunement, we see what the child initiates and ask what would support their development.

Each conceptual framework referred to in this article supports assessment and treatment methods with varying degrees of conceptual and psychometric integrity. The normative functional skill approach supports the major screening and cognitive (or top-down) approaches to intervention for children with developmental delays. The general abilities approach and traditional neuro-developmental theory are not well supported by recent research methods. The dynamic systems approach supports promising trends in biomechanical or kinematic analysis of movement, ecological task analysis, and task-specific intervention. More recently, the cognitive neuro-scientific approach has generated some examples of process-oriented assessment and treatment based on validated (brain-behaviour) models of motor control and learning (Wilson, 2005). A multi-level approach to movement assessment and treatment is recommended for children with developmental delays, providing a qualitative description of motor development at different levels of function: behavioural, neurocognitive, and emotional (Cantell, Kooistra, & Larkin, 2001).

Future directions

Future research needs to emphasize the evaluation and enhancement of the child's function and expression through increasing a qualitative range of movement choices that allow adaptability and choice. Clinicians need encouragement to meet a child where they are and support their capacity with dynamic and developmentally based protocols. Experiential research from dance and movement fields can articulate a developmental paradigm and the qualitative range of movement which is indicative of functional adaptability in later motor, cognitive, and social development in children to inform assessment and intervention. This vocabulary that expresses a qualitative continuum can support and empower parents and clinicians to align with their own skills of kinesthetic attunement. This facilitates communication between caregivers and clinicians about experiential evidence and diagnostic criteria. Markers of tone, adaptability, and transition allow clinicians to both assess observable phenomena and support development. Holistic observation markers for midline and weight sensing allow the clinicians to attune their kinesthetic skills and develop complementary protocols for intervention.

Once the therapist or caregiver respects attunement and developmental protocol, latent variables are exposed in common movement experiences. It is notable that observation and intervention overlap in movement choices that encourage the experience of midline and weight sensing in a supportive environment, such as: rolling in flexion, hugging, gathering in, holding and releasing objects, supported weight shift, direction change, and level change. These experiences support an ability to make transitions in time, space, and quality and address fundamental integration that is often lacking in children with developmental delays. In addition to their application in practice, many of the movement themes observed in children with developmental delays continue to be meaningful in adulthood. In times of stress, we often lose our relationship to the supporting gravity as well as our midline organization. Therefore, these basic concepts are essential in dance/movement-based supervision and for our personal growth as movers.

The dynamic process of our research includes further discussions, observations, artistic inquiry, and returning to the foundations of movement. We continue to revisit the data and collect further data from diverse populations to extrapolate both quantified and narrative results. In this process we are refining both the movement-based tool and the methodology of attuned observation.

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