13th International Conference on Developmental Coordination Disorder
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Abstract Book

*For clarity’s sake and without changing the textual contents the structure of some abstracts has been edited to match each other by using similar subtitles.
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The Zurich Neuromotor Assessment: Update and new norms

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Background and aim

The Zurich Neuromotor Assessment (ZNA) describes the developmental course and inter-individual variation for timed performance and quality of movements in typically developing children from 5 to 18 years old. As the original data collection of the ZNA was more than 20 years ago, an update was necessary. There are three main updates in the new version of the ZNA. Firstly, the age band is extended to include 3 and 4 year olds, secondly, unreliable items are replaced, and thirdly, the included tasks stay identical throughout the entire age range.

The aim of this study was to provide normative motor proficiency data in typically developing children between 3 and 18 years of age using an updated version of the ZNA (ZNA-2).

Method

A total of 616 typically developing children between 3 and 18 years of age were enrolled from day-care centres, kindergartens and schools, and were administered the ZNA-2. Motor proficiency was assessed with 14 different tasks allocated into five components (fine motor tasks, pure motor tasks, static balance, dynamic balance, and contralateral associated movements). Motor performance was determined as a function of age and sex. Intra-observer, inter-observer and test-retest reliabilities were evaluated.

Results

Most ZNA-2 tasks featured a marked developmental trend and substantial inter-individual variability. Test-retest reliability was generally high on the five components (fine motor, 0.78; pure motor, 0.84; static balance, 0.67; dynamic balance, 0.78, contralateral associated movements, 0.81; and total score, 0.84). Intra-observer and inter-observer reliabilities were high (from 0.72 to 1.00).

Discussion and conclusion

The ZNA-2 as an updated version of the ZNA is a reliable test instrument to measure motor proficiency in 3 to 18 year old children. It allows continuous measurement for the entire age range without changing test items. This feature of the ZNA-2 is unique and makes it applicable for clinical purposes. The ZNA-2 has no ceiling or bottom effects and is therefore very suitable for assessing motor abilities in its wide variety from poor motor performance to extremely skillful.

Keywords: inter-individual variability, neuromotor assessment, clinical applicability, norms
Assessing the discriminant validity of the Zurich Neuromotor Assessment 2 in Dutch preschoolers

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Background and aim

Preschool age is an important period for motor development. Early detection of motor coordination difficulties, including Developmental Coordination Disorder (DCD), is often stressed in order to enable early intervention. Although the Movement Assessment Battery for Children Second Edition (MABC-2; Henderson, Sugden, & Barnett, 2007) is a widely used motor test, there is no golden standard for detecting DCD. Recently, the Zurich Neuromotor Assessment 2 (ZNA-2; Kakebeeke et al., 2018) has been developed in Switzerland. The ZNA-2 aims to describe motor development in children aged 3 to 18 years by focusing on both quantitative (motor speed) and qualitative (contralateral associated movements) aspects of motor functioning. Unlike most motor tests that assess motor competence with typical every day motor skills, the ZNA-2 also includes tasks measuring motor abilities, thereby giving information about the neurological cause of motor competence. A possible additional advantage of this perspective is that the ZNA-2 could be less sensitive to motor experience than the MABC-2.

The aim of the current study was to examine whether the ZNA-2 is a useful tool to detect preschoolers at risk of DCD in the Netherlands (discriminant validity).

Method

Children aged 3 to 5 years with an IQ > 70, no visual and/or auditory impairments, and no suspected or diagnosed neurological or medical condition have been recruited into the study. During April 2016 and July 2018 175 children have been assessed (88 boys; mean age = 50 months (SD = 10). They have been assessed with the ZNA-2 and the MABC-2-NL. To analyze whether the motor tests detect the same children being at risk of DCD (scoring ≤ 16th percentile), we are currently in the process of comparing the percentile scores of the ZNA-2 with the percentile scores of the MABC-2-NL.

Results

The outcomes of the comparison between the percentile scores of the ZNA-2 and the MABC-2-NL will be presented at the conference. Based on a recent study examining the discriminant validity of a former version of the ZNA-2 in Swiss preschoolers (Kakebeeke et al., 2014), it is expected that the ZNA-2 detects a larger proportion of preschoolers at risk of DCD than the MABC-2-NL.

Discussion and conclusion

The results concerning the discriminant validity of the ZNA-2 could have implications for the applicability of the ZNA-2 to detect preschoolers at risk of DCD in the Netherlands.

Keywords: preschoolers, Developmental Coordination Disorder, Zurich Neuromotor Assessment 2, motor test
Cultural influences on the motor development of young preschoolers – impacts on identification of children at risk

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Background and aim

There is increasing consensus that Developmental Coordination Disorder (DCD) is a lifelong condition. Onset is apparent in the early years, yet DCD is not typically diagnosed before age 5, potentially due to the broad range of acceptable early childhood developmental markers. Tendencies for delayed diagnosis results in a clinical dilemma: this reduces access to early intervention which might prevent further delays and facilitate secondary consequences of developmental conditions. Valid, reliable and functional screening tools are needed to identify children who warrant early support and monitoring. However, tools developed in one culture may not be psychometrically sound when used in others. Furthermore, the development of tools is complicated by variance in a) acceptable motor milestone achievement, b) what is considered appropriate functional tasks for children between 3-5 and c) exposure to different cultural influences that are likely to impact on motor performance. The Little Developmental Coordination Disorder Questionnaire (LDCDQ) was developed to screen young preschoolers for early functional motor difficulties based on culturally familiar tasks, as compared to children of the same age and gender. The international LDCDQ collaboration aims to ensure psychometrically sound, comparable versions of the tool; this report aims to consider differences between reported motor outcomes of typically developing children across cultures.

Method

The 15-item LDCDQ is intended for use with young preschoolers aged 3-4.11. A total score in calculated, as well as three subscores (control during movement/fine motor/general coordination). Researchers from multiple international sites have adapted local versions of the LDCDQ, following agreed guidelines for development including consideration of issues of language and local cultural norms; results from 18 sites will be reported here. Stringent processes for psychometric testing have been adhered to.

Results

Comparison between typically developing children (n=841) from 18 sites revealed significant differences for the total LDCDQ score (F[17, 823]=6.82; p<0.001; &#951;2=0.12). Significant differences were also found for each LDCDQ subscore.

Discussion and conclusion

Understanding motor development differences between typically developing children from different cultures is vital, as this provides foundations for understanding assumptions made about those with motor delay. This has important implications for the assumptions made by developers and users of DCD screening and assessment tools, and subsequent intervention and support. This is the first attempt to develop an instrument with the aim of facilitating cross-cultural comparison of motor development and delay in young preschoolers, which will enable a unified language for researchers and clinicians working in this field.

Keywords: Preschoolers, Motor, Culture, Assessment
Comparison of three motor skills assessment tools used in Finland

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Background and aim

Early educators observe and interact daily with children. They search for feasible, reliable and valid tools to chart children’s motor development, and recognize children at risk of Developmental Coordination Disorder (DCD). In Finland, three different motor assessment tools are used in a preschool context: Alle kouluikäisten lasten havaintomotorisia ja motorisia perustaitoja mittaava testistö (APM; Numminen, 1995), Test of Gross Motor Development-3 (TGMD-3; Ulrich, 2013) and Körperkoordinationstest für Kinder (KTK; Kiphard & Schilling 1974; 2007). The APM was developed for the use of teachers to recognize children’s (1-7 years) perceptual-motor and fundamental motor skills. The TGMD-3 is a process-oriented assessment of locomotor and object control skills in 3 to 12 year old children. The KTK measures children’s (5-14 years) body coordination.

The aim of this presentation is to compare the aforementioned motor assessment tools, mainly their feasibility from preschool teachers’ point of view. Another aim is to examine if TGMD-3 and KTK recognize the same children to show poor motor performance in a national data set.

Method

In Finland, there are three large datasets collected using the APM, TGMD-3 and KTK. Data with the APM was collected in 1991-1992 with 1062 preschool children. The TGMD-3 (n = 1095) and KTK (n=520) were used as part of the 'Skilled Kids’ -project in 2016-2017. Feasibility of the three tools was examined based on field experiences, literature review, and percentile comparisons of the TGMD-3 and KTK in a dataset of 400 children from the 'Skilled Kids’.

Results

All the three tests have pro’s and con’s. The APM taps multiple aspects of motor performance. It is easy to use but requires two separate assessment sessions. The object control items in the TGMD-3 are difficult for preschoolers and no balance items are included. The KTK is a well-informative tool to assess body coordination and balance skills, but no manipulative skills are included. In the TGMD-3, 68 children scored below 15th percentile, and 23 below 5th percentile. In the KTK, 61 children scored below 15th percentile and 21 below 5th percentile. Twenty-eight children scored below 15th percentile in both tests.

Discussion and conclusion

The three motor assessment tools measure different aspects of motor performance. Each tool has their own strengths and weaknesses. They might also recognize children at risk for DCD. However, in the future there is a need to examine if these tools recognize the same children with and without motor difficulties.

Keywords: feasibility, pre school, motor tests
Prevalence of co-occurring Developmental Coordination Disorder in children and adolescents with Autism Spectrum Disorder

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Background and aim

Autism Spectrum Disorder (ASD) and Developmental Coordination Disorder (DCD) are common developmental disorders with shared motor challenges. The aim of the present study was to explore the prevalence of DCD features in individuals with ASD.

Method

We tested a total of 56 children and adolescents diagnosed with ASD (n = 38) and DCD (n = 18) between 5 and 18 years of age (9 females). All participants had a prior diagnosis of ASD or DCD, respectively, based on DSM-IV or DSM-V criteria. In the lab, they were evaluated with the Developmental Coordination Disorder Questionnaire (DCD-Q), the Movement Assessment Battery for Children, 2nd edition (MABC-2), and the Beery-Buktenica Developmental Test of Visual-Motor Integration, 6th edition (Beery VMI-6).

Results

A comparison of the ASD and DCD groups on all assessments indicated no significant differences for the Beery-VMI, MABC-2, and their categories. However, scores on the DCDQ were significantly higher for the ASD group (p = .04) than the DCD group. Frequency analyses indicated that over 90% of the individuals with ASD scored on the “suspect or indication of DCD” category of the DCDQ, and over 97% (all but 1) scored below the 16th percentile of the MABC-2 assessment.

Discussion and conclusions

Our results indicate that over 90% of the individuals with ASD could potentially be diagnosed with DCD as a co-occurring condition to ASD. We recommend that the evaluation of potential DCD in individuals with ASD be performed systematically and thoroughly. It is important to diagnose and promote interventions for DCD as the condition has been associated to severe health consequences. Further studies should investigate the prevalence of DCD in individuals diagnosed with ASD. Answering the question of co-occurrence rates will inform practice guidelines with respect to surveillance, assessment, and intervention.

Keywords: ASD, developmental disorders, co-occurrence, co-morbidity
Treated prevalence of Developmental Coordination Disorder (DCD) and Autism Spectrum Disorder with co-occurring DCD is significantly less than estimated prevalence at both primary and specialty care sites

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Background and aim
Given recent changes to the DSM-5 (American Psychological Association, APA, 2013), Developmental Coordination Disorder (DCD) and Autism Spectrum Disorder (ASD) can be diagnosed as co-occurring (ASD+DCD), but clinicians have long acknowledged the presence of motor symptoms in ASD. ASD+DCD requires integrated care, due to symptom complexity. In Tarrant County, Texas, Cook Children’s Medical Center (CCMC) network and the Child Study Center (CSC) are sites with primary care (e.g., pediatrics/developmental pediatrics) integrated with services specific to ASD (e.g., applied behavior analysis). However, the treated prevalence of DCD and ASD+DCD remains low compared to observed prevalence in our lab. We aimed to measure treated prevalence of DCD and ASD+DCD at these sites, and determine whether they serve a patient population proportional to the estimated prevalence. We hypothesized that the number of patients with DCD, and ASD+DCD served by CCMC and CSC would be significantly lower than estimated prevalence in Tarrant County.

Method
We retrospectively evaluated charts from 1994 to 2018 for patients who were 0-21 years old at the time of first chart entry, with a diagnosis of DCD or ASD+DCD. We compared the treated prevalence of DCD and ASD+DCD at CCMC and CSC to expected prevalence rates.

Results
Estimated ASD prevalence is 1.5% (Centers for Disease Control, 2018), or 8,078 children in Tarrant County; estimated DCD prevalence is 7% (APA, 2013), or 37,695 children in Tarrant County, based on 2016 census data. At CCMC, the number of patients since 1994 with ASD was 5,520, or with DCD was 424, and with ASD+DCD was 59. At CSC, the number of patients since 1994 with ASD was 1,559, with DCD was 46, and with ASD+DCD was 232. The CCMC electronic medical record contained 32 different diagnostic codes for ASD (e.g., Asperger’s Syndrome, active infantile autism) and 4 codes for DCD (e.g., dyspraxia).

Discussion and conclusions
The number of patients served was disproportionate to the estimated population, perhaps due to low awareness of DSM-5 changes allowing ASD+DCD co-diagnosis or of DCD in general. Other agencies serve a small, non-overlapping population with ASD that is unlikely to make up the difference. There is a clear gap in the number of patients with ASD, DCD, and ASD+DCD served at integrated care sites. Many children may be (1) undiagnosed, (2) diagnosed but not seeking care in an integrated care site, or (3) inaccurately diagnosed. Inconsistency in diagnostic coding and referral practices may elevate the risk for missed diagnosis.

Keywords: co-occurrence, Autism Spectrum Disorder, prevalence, Developmental Coordination Disorder
Minority females are especially vulnerable to health disparities in diagnosis and treatment of Developmental Coordination Disorder (DCD) and Autism Spectrum Disorder with and without co-occurring DCD

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Background and aim

An estimated 1.7% of children are diagnosed with Autism Spectrum Disorder (ASD), and females are diagnosed 4-5 times less frequently than males (CDC, 2018). An estimated 5-7% of children are diagnosed with Developmental Coordination Disorder (DCD) (APA, 2013), and females are diagnosed 3-4 times less frequently than males (Dyspraxia Foundation, 2010). Recent evidence suggests that this difference in prevalence may not reflect true biological sex differences, but rather represents gender-based biases (Constantino & Charman, 2012; Loomes et al., 2017). Minority females may be at greatest risk for missed or delayed diagnosis, given documented disparities in the ASD literature (Mandell et al., 2009) and the additive or multiplicative effects of intersectionality in health disparities (Slopen et al., 2016; Alegria, Vallas, & Pumariega, 2011).

Method

Data were extracted from the electronic medical records of the Cook Children’s network in Fort Worth, Texas for patients with a diagnosis of DCD, ASD+DCD, or ASD who were 0-21 years of age at the time of first chart entry. A total of 5,578 cases from 1994-2018 met inclusion criteria, and a sample of 5,562 cases (M = 4,377; F = 1,185) had complete data on sex, race, and ethnicity.

Results

The male to female ratios for DCD (M = 62%, F = 38%; approximately 2.7:1) and ASD+DCD (M = 73%; F = 27%; approximately 3.7:1) within the electronic medical records were smaller than expected given U.S. prevalence estimates, despite the fact that ratios for ASD (M = 80%, F = 20%; approximately 5:1) were larger than expected. Upon preliminary examination of sociodemographic effects, the overall percentage of minority patients with DCD (35%), ASD+DCD (27%), and ASD (40%) was quite low relative to that of white non-hispanic (WNH) patients. More detailed examination revealed that there were half as many minority females relative to WNH females, half as many minority females relative to minority males, and a third to a quarter as many minority females relative to WNH males in all three diagnostic groups.

Discussion and conclusion

These data suggest that while gender disparities are not consistent across diagnostic categories, there may be a multiplicative effect of intersectionality, such that minority females are at risk for missed diagnosis. Rigorous research is needed to determine whether estimated prevalence differences between males and females, and across racial/ethnic groups, are biologically- or sociologically-driven. Provider- and patient-centered education may be required to increase surveillance among females, especially in vulnerable groups.

Keywords: diagnosis, Autism Spectrum Disorder, health disparities, Developmental Coordination Disorder
Atypical attention to socially-relevant stimuli in developmental coordination disorder

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Background and aim

Difficulties with social skills are reported in developmental coordination disorder (DCD), but it is unclear to what extent these reflect co-occurrence with autism spectrum disorder (ASD), or whether the social difficulties in the two disorders differ. Cross-syndrome comparisons attempt to ascertain disorder specificity. The present study employed eye tracking methodology to compare attention to socially-relevant stimuli in these disorders.

Method

The sample comprised 28 children with DCD, 28 children with ASD, and 26 TD age-matched controls (all aged 7-10). Eye movements were recorded (Eyelink 1000) while children viewed 30 images, half showing one person in a scene and the other half depicting a social scene with two or more people. Analyses first considered viewing time to different regions of the images and then investigated gaze following behaviour.

Results

Compared to children with ASD, children with DCD spent, on average, more time looking at the face and, in particular, the eye regions of the actors shown in the images. However, this difference was not statistically significant. Children with DCD performed in between the ASD and TD groups, with the TD group spending the most time fixating in these regions. Interestingly, 29% of the DCD group and 21% of the ASD group did not spontaneously follow the actors’ gaze to an object in the scene.

Discussion and conclusion

Children with DCD exhibited atypicalities in their attention to socially-relevant information, most notably in their difficulty with spontaneously following gaze. Subtle difficulties with gaze following may transfer to more significant problems in real-life scenarios in terms of understanding others and building relationships. The findings confirm social atypicalities in DCD, but highlight that they may be different in nature to those seen in ASD. More attention should be given to understanding the full range of difficulties experienced by those with DCD.

Keywords: social-stimuli, autism, DCD, eye-tracking
Field testing of motor performance in children with DCD in low-income communities

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Norm-referenced, standardized, motor and fitness assessments for children with motor deficits living in low-income communities are lacking, limiting early detection and quantification of prevalence estimates in these settings. Low-income communities provide suboptimal conditions for child development and are often associated with the lack of motor learning experiences. Moreover, opportunities for motor skill acquisition and appropriate sports-oriented practices are unavailable leading to lower fitness levels. It is therefore important to develop cost-efficient tools that can be used to characterize neuro-motor fitness and to investigate potential factors that are associated with poor motor skills during critical periods across developmental time.

Currently none of the available motor skill or anaerobic fitness tests have norms for developing countries and/or low-income communities. Importantly, even without appropriate norms, most test equipment is very expensive for therapists working in low resourced areas. We therefore decided it was important to develop a new motor and fitness test suitable for these circumstances. This workshop will review the theory behind the development of the test items (task loading) and show data collected so far, will discuss the need and means to standardize a context-specific test battery in low-income settings and will debate on collaborating with the participants in future research efforts for informing the promotion of health related fitness and motor development in low socioeconomic environments. Lastly participants can try out some of the items and developed materials.

**Keywords:** fitness assessment, motor performance test, low-income countries, big data
The Kids-BESTest: how to perform a comprehensive assessment of postural control in school-aged children

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Aims: The aims of this workshop are to:

(1) Improve participant’s knowledge on the dimensions of postural control and assessment requirements according to the systems approach framework.

(2) Teach participants how to apply and score a new comprehensive assessment of postural control for school-aged children, the Kids-BESTest.

Tool description: Disordered postural control contributes to significant activity and participation limitations in children with disorders of motor control, including DCD. Until recently, no comprehensive assessment of postural control existed for school-aged children. The BESTest is a new comprehensive assessment of postural control which examines all components of the systems approach framework. It was originally designed and successfully used with adults. We have now completed an adaptation for children, called the Kids-BESTest, and established that it has sound psychometric properties for school-aged children.

In this workshop, we will provide

(1) Background theory on postural control definitions, frameworks for clinical application and the development of the Kids-BESTest.

(2) Participants will be taught how to apply the items of the Kids-BESTest and provided instruction sheets, score sheets and links to a website for further online training/practice.

(3) Participants will be shown videos of children with various levels of ability being assessed on the Kids-BESTest and given the chance to practice scoring items in real time.

Practical relevance:

(1) Participants will have an improved understanding of postural control

(2) Participants will have a framework for understanding postural control in children with motor control disorders

(3) Participants will have skills in applying a comprehensive clinical assessment of postural control in children which will improve their ability to profile abilities and difficulties and selection of appropriate interventions

Keywords: school-aged children, Kids-BESTest, assessment, postural control
Observational motor learning in children with DCD – An EEG study

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Background and aim

The aim is to investigate the mirror neuron system (MNS) hypothesis of DCD which has been proposed as an explanation for the difficulties in learning and performance of new motor skills in these children. Children with Developmental Coordination Disorder (DCD) experience problems with learning and performing motor skills. Automatic activation of the MNS during action observation and its coupling to the motor output system are important neurophysiological processes that underpin observational motor learning. In the present study we used EEG-based measures of MNS activation to test putative deficits in MNS function in children with DCD.

Method

Motor neural network activation was measured by EEG, specifically event-related desynchronization (ERD) of mu rhythms and fronto-parietal coherence. We tested 15 children with DCD and 15 matched controls in two task conditions: observational learning (imitate an action following observation of that same action) and detection (report a deviant movement after observation). In accordance with the hypothesized disruption of the MNS in children with DCD were predicted to show less mu-suppression and coherence compared with their non-DCD peers during observational learning, specifically.

Results

As predicted, children with DCD showed lower levels of mu suppression and reduced modulation of coherence during the observational learning task compared with their non-DCD peers.

Discussion and conclusion

Learning a new movement via action observation is important for acquiring new motor skills. This form of learning entails the transposition of the observed action to the existing internal representations of the observer’s own motor system. The present neurophysiological results suggest that this process of learning is impaired in children with DCD. Results are discussed in relation to current hypotheses on mechanisms of DCD.

Keywords: Internal Modeling, MNS, Action Observation, DCD
Imitation of typical and atypical biological motion kinematics in individuals with Developmental Coordination Disorder

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Background and aim

Imitation is a powerful mechanism that supports motor learning. During learning through imitation lower-level visuomotor processes are thought to represent biological motion kinematics of the observed movement. Earlier research has shown that imitation of transitive and intransitive gestures is less accurate in children with DCD. It is therefore tempting to relate the motor learning impairments in DCD to deficits in imitation. However, as current work on imitation in DCD is limited to research paradigms in which only the outcome of a gesture is compared with a model, it is unclear how the actual imitative action is accomplished. In other words, it remains to be elucidated to what extent the deficits in imitation found in individuals with DCD can be explained by an impairment of the lower-level visuomotor processes or, alternatively, by deficits in other, for example attentional, processes. To this end the present study was designed to investigate the integrity of the lower-level visuomotor processes involved in imitation learning in individuals with DCD.

Method

We recruited a sample of adolescents and young adults with DCD (16 – 25 years of age) and a control group matched for age and gender. The participants were submitted to a protocol developed by Hayes et al. [Acta Psychologica, 163, 10-16 (2016)] to examine imitation learning in individuals with autism spectrum disorder (ASD). While sat down in front of a computer monitor, the participant was instructed to watch the movement of a model, a white cursor (diameter = 8mm) displaying a single horizontal trajectory from left to right, with an amplitude of 200mm and a movement time of 1700ms. Then, the participant was requested to imitate the spatio-temporal characteristics of the cursor by moving a hand-held stylus from the home to the (estimated) location of the end target on a graphics tablet. The characteristics of the model varied: 1) typical biological motion with peak velocity at 50% of the movement time, 2) atypical biological motion with peak velocity at 17%, and 3) atypical non-biological motion with constant velocity. Movement kinematics exhibited by the participants, including movement time, end-point accuracy, amplitude and timing of peak velocity were compared across conditions and groups.

Results

Data analysis is still in progress.

Discussion and conclusion

This study will provide insight into the low-level visuomotor processes involved in imitation learning in individuals with DCD. Moreover, this study will allow comparison of sensorimotor deficits found in those with DCD and ASD.

Keywords: imitation, ASD, motor learning, visuomotor processes
Implicit motor sequence learning in adults with and without Developmental Coordination Disorder (DCD)

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Background and aim

To examine implicit motor sequence learning in adults with and without DCD using a serial response time (SRT) task. Even though individuals who have DCD may have difficulties learning a motor skill, few studies have examined the mechanisms involved. Understanding these mechanisms and whether individuals with DCD show selective deficits would be of theoretical and practical interest. It would also assist in the design of strategies and interventions to address related challenges. The SRT task is an established method of investigating implicit learning.

Method

This study included 11 participants with DCD that met the DSM-IV criteria and 18 without DCD (aged 18 – 61 years) matched as closely as possible for age and gender. All participants were screened using the Adult Developmental Co-ordination disorder Dyspraxia Checklist (ADC), the Bruininks-Oseretsky Test of Motor Proficiency (BOT-2), the Raven’s Standard Progressive Matrices (RSPM) test, the Wender Utah Rating Scale (WURS) and the Edinburgh Handedness Inventory (EHI). Learning was then measured using a SRT task. Following the SRT, a free generation task (FGT) assessed explicit sequence knowledge. Resulting accuracy and response time (RT) data were analysed via Condition x Block ANOVA.

Results

For the screening tests, the DCD group performed statistically worse than the control group in the ADC, BOT-2 and the WURS. Both groups were able to complete the SRT task and showed comparable accuracy. However, the DCD group were significantly slower overall to complete the task. Further, a Condition x Block interaction during the learning phase was explained by a failure of the DCD group to improve their performance, while the control group showed the typical learning effect of gradually faster RTs. Responses on the FGT also revealed that the DCD group acquired significantly less sequence knowledge than the control group during the task.

Discussion and conclusion

The results of our (albeit small) study show that adults with DCD failed to demonstrate the typical signs of implicit (procedural) learning on an established and influential sequence learning task. In addition, difficulties in acquiring task-related knowledge may point towards more complex problems in learning motor skills. The SRT task is well-suited to further investigation in this population and further research is indicated.

Keywords: adults with DCD, implicit motor sequence learning, reaction time, free generation task
Facilitating motor planning of a grip selection task using explicit motor imagery instructions in children with Developmental Coordination Disorder

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Background and aim

Evidence suggests that impaired motor planning is a core feature of children with DCD. This could result from their inability to automatically engage internal modelling processes and compensate using of other strategies such as minimal rotation of the wrist to complete the actions. In this study, we investigated whether explicitly asking children with DCD to imagine then immediately execute motor sequences improved their motor planning resulting in similar performances as their typically developing peers.

Method

Boys with (n=14) and without DCD (n=20) aged between 7-12 years completed a grip selection (octagon) task involving either one or two colour sequences. Participants performed the task under two conditions; Motor planning (MP) and Motor imagery and planning (MIP), which included an explicit instruction to imagine performing the movements before execution. Percentage of trials achieving end state comfort (ESC) and/or using minimal rotation (MR) were noted. Trials using neither of these strategies were recorded as ‘other’.

Results

For the MP condition, children with DCD favoured a MR strategy compared to their peers for both the one (p=0.006) and two colour sequences (p=0.015) which resulted in fewer movements ending in ESC for both the one (p=0.004) and two colour sequences (p=0.028). For the MIP condition, children with DCD completed fewer trials in ESC than their peers for the two colour sequences only (p=0.011). This appeared to be due to an increase in their use of other strategies (p=0.013). In those with DCD, a greater number of trials ended in ESC for both one (p=0.014) and two colour (p=0.034) sequences in the MIP compared to the MP condition. This went hand-in-hand with a reduction in the use of MR for one (p=0.005) and two colour sequences (p=0.002).

Discussion and conclusion

Results confirmed the use of MR instead of ESC when planning motor tasks in children with DCD. Introducing explicit motor imagery instructions to this population significantly reduced their use of MR and increased their number of trials ending in ESC, resulting in similar performances to those without DCD. Interestingly, when task complexity was increased, those with DCD employed ‘other’ non-optimal strategies rather than successfully engaging an ESC strategy. This could result from their inability to imagine complex tasks.

Children with DCD might not fully engage in internal modelling processes when planning tasks. Explicit instruction to imagine tasks before completion could potentially be a strategy that could help them to plan as efficiently as typically developing children.

*Keywords: ESC, internal model, DCD*
The effect of task complexity on motor planning ability in children with and without developmental coordination disorder (DCD): Disentangling elements of the planning process

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Background and aim

The aim of this study was to examine what elements of the motor planning process are compromised in children with DCD as compared to their typically developing (TD) peers. Motor planning can be defined as the ability to anticipate the end of an upcoming movement prior to commencing movement. Previous studies found that children with DCD show compromised motor planning as compared to their TD peers. In these studies most experimental tasks could however be performed even without correct planning. Moreover, in most studies only the end-state comfort was used as a dependent variable for planning. Here, we designed a task that necessitated preplanning in order to be able to complete the task, and we measured different time events to allow more precise assessment of the planning process.

Method

Participants were children 5-12 years old. We already collected data of 311 TD children and are currently collecting data of children who meet the DSM-V diagnostic criteria for DCD. The motor planning task was a hexagonal knob task in which participants needed to grasp and rotate a handle. The aim was to complete the rotation movement in a single movement without adjusting the initial grip. Participants performed 48 trials in total: 24 control trials (i.e., 60° and 120° turn) and 24 critical trials (i.e., 180° and 240°). In the latter, comfort of the initial grip needed to be sacrificed in order to successfully complete the task. For each trial, we measured the grip used and we assigned a score of 1 (i.e., successful task completion) or 0 (i.e., no successful task completion). Furthermore, we measured three time events that reflected different phases of the motor planning process.

Results

Preliminary results indicated that for TD children, performance accuracy decreased and reaction time increased when the complexity of the rotation movement increased, especially for the 240° rotations. Interestingly, while the time to movement onset decreased with increasing age, the subsequent movement time remained relatively stable with increasing age.

Discussion and conclusion

The results from TD children showed that the hexagonal knob task was successful in increasing the need for motor planning and in disentangling different aspects of the motor planning process. Data from children with DCD will be presented during the conference.

Keywords: Children, Developmental Coordination Disorder, Motor planning
A new protocol for assessing imitation and action observation abilities in children with DCD: a pilot feasibility and reliability study

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Background and aim

To develop a comprehensive protocol for assessing imitation of meaningless and meaningful gestures and action observation abilities in children with DCD and to examine its psychometric properties in children with DCD and typically developing (TD) children. For learning and consolidating manual skills in children with DCD, imitation and AO are considered fundamental modalities. Knowledge about these modalities in children with DCD is scarce and a comprehensive assessment protocol is lacking.

Method

The imitation test includes 12 meaningful and 20 meaningless gestures. The AO test consists of performing two assembly tasks after video-observation. Items of both tests are rated on a 4-point scale. Twelve children with DCD (mean age 8y2m, range 6-10y) and 11 TD children (mean age 8y1m, range 6-11y) were included. Intra and inter-rater reliability for DCD, TD and total group was determined by intraclass correlation coefficients (ICC) for total scores and weighted kappa (K) and percentage agreement for items. Known group validity was assessed by comparison of the DCD and TD group with the Wilcoxon rank sum test. Spearman coefficient was used for construct validity by correlating standard score of manual dexterity domain of MABC2 with total score of imitation and AO test. Based on these preliminary results, adaptations to the protocol were made through experts panel discussion and confirmed by an intra and inter-rater reliability study in a new sample of 11 DCD children (mean age 7y4m, range 6-11y).

Results

For the final protocol of the imitation test, both excellent intra and inter-reliability was found for meaningful (ICCs=0.93) and meaningless (ICCs=0.98) gestures. Also for the AO test, excellent ICCs were reported for intra and inter-rater reliability (ICCs=0.95). K values ranged between 0.28-1.0 and 0.37-1.0 for meaningful and meaningless gestures respectively, and 0.69-1.00 for AO test items. Percentage of agreement was >60% for imitation test items and >80% for AO test items. A significant difference between DCD and TD group was found for meaningless gestures (p<.001) and AO abilities (p<.01). Low correlations were found between the manual domain of MABC2 and meaningful gestures (r=.20, p=.60) and AO test in the DCD group (r=0.34, p=.32).

Discussion and conclusion

The results support the reliability and known group validity of this imitation and AO test in children with DCD. When fully validated, this novel assessment may contribute to mapping of the deficits in imitation and AO abilities, which in turn may facilitate delineating rehabilitation programs.

Keywords: new protocol, action observation abilities, imitation, meaningless and meaningful gestures
Stability and change in motor performance and its relationship with executive functioning in preschool children

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Background and aim

Although there is some evidence that motor performance and executive functioning are related in young children, the precise nature of the relationship remains unclear. Both domains have been described in terms of wide intra- and interindividual variability during the preschool years. The aim of this paper is to examine the degree of stability and change in motor performance and executive functioning of young children with different levels of motor skill proficiency, including typically developing children and children at risk for motor coordination difficulties.

Method

This paper stems from a longitudinal project 'Motor, Executive functioning, Language, and LEarning outcomes (MELLE)' which focuses on the developmental trajectories of motor skills, executive functions, and language in preschool children. Children aged 3 to 5 years with an IQ > 70, no visual and/or auditory impairments, and no suspected or diagnosed neurological or medical condition have been recruited into the study. Between April 2016 and July 2018 ±75 children have been assessed at three time points, six months apart, on measures of motor functioning (Movement Assessment Battery for Children-2) and verbal and nonverbal measures of executive functions (i.e., inhibition and working memory). Children scoring at or below the 16th percentile are classified as at risk for motor coordination difficulties. We are currently in the process of analyzing the full dataset.

Results

The results of the full dataset will be presented at DCD13. Preliminary results with a subsample using two measurement points showed a significant relationship between the group classification at T1 and the group classification at T2, which indicates stability. Nevertheless, there are also several children who show progress or decline at T2. In addition, the results suggest that the degree of stability in motor functioning does not lead to differences in the development of executive functioning in typically developing children and children at risk for motor coordination difficulties.

Discussion and conclusion

The findings on stability and change underline the value of utilizing data from more than one measurement point in order to capture how motor performance in related to executive functioning in young children.

Keywords: early childhood, development, motor functioning, executive functions
An Investigation of Motor and Executive Function skills in Children with and without Developmental Coordination Disorder

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Background and aim

It has been reported that children with DCD also have difficulties with EF that further impact their behaviour at home and school. EF is a set of skills relating to the monitoring and planning of behaviour that includes working memory, mental flexibility and inhibition. Inhibition can be further divided into interference control, in which irrelevant information must be ignored to complete a task and response inhibition in which an automatic response must be overridden. A range of tasks requiring motor or verbal responses have been used in studying inhibition in DCD. However, findings are inconsistent and the relationship between motor skills and EF is unclear. This study aims 1) To Examine the Executive Function (EF) skills of children with and without DCD, with a focus on inhibition, using questionnaires, verbal and motor tasks. 2) To examine relationships between EF measures and fine and gross motor skills within and across both groups.

Method

24 children with DCD aged 6-9 years, plus 24 typically developing children matched on age and gender will take part. Children with DCD will undergo a full diagnostic assessment to ensure the DSM-5 diagnostic criteria are met. Interference control will be measured using a Flanker Task and the 'Animal Colours’ test from the Intelligence and Development Scales for Children and Adolescents (IDS-2). Response inhibition will be measured using an adapted verbal and motor inhibition task. A parent/teacher report measure, the Behavior Rating Inventory of Executive Function®, Second Edition (BRIEF® 2) will also be used to measure inhibition and EF skills. Fine and gross motor skills will also be assessed using the IDS-2 psychomotor component and the Movement ABC-2 Test.

Results

Data from the two groups will be compared across the Inhibition/EF measures. The relationship between Inhibition/ EF measures and fine/gross motor skills will also be examined within and across the groups.

Discussion and conclusion

The significance of these results will be discussed in relation to current understanding of motor and EF difficulties in DCD and any potential impact on participation and clinical practice explored. Conclusions will be drawn regarding the EF skills of children with and without DCD and the relationship between EF and fine/gross motor skills. Directions for further research will be highlighted.

Keywords: Executive Functions, Motor Skills, Inhibition
Neuropsychological profiles of children with DCD aged 8-10 years: beyond movement difficulties

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Background and aim

Study aims to characterise intelligence, language, attention and motor speech abilities in school-aged children with DCD. It is well established that there is a high rate of co-occurrence between speech and language disorders, attention difficulties, and movement difficulties in developmental conditions. Yet little work has been done to examine the relationship between motor coordination difficulties and difficulties outside the motor domain in children with DCD. This lack of precise neuropsychological characterization may hinder the development of intervention and support strategies that could benefit children with DCD.

Method

Thirty-six children aged 8-10 years who met DSM-5 criteria for DCD and 17 age-matched control children were recruited. Children were assessed for (i) general motor skills using the Movement Assessment Battery for Children (M-ABC2), (ii) IQ using the Wechsler abbreviated scale of intelligence (WASI-II), (iii) expressive and receptive language using the Clinical Evaluation of Language Fundamentals (CELF-4 UK) (iv) attention using the Test for Everyday Attention in Children (TEACh), and (v) speech motor skills using the Verbal Motor Production Assessment for Children (VMPAC).

Results

Over 40% of children with DCD displayed impaired oral motor control, and almost a quarter showed impairments on sequencing articulatory movements. Additionally, over 40% of children had impaired executive functions (including processing speed, sustained attention, and cognitive control/switching) and scored more than 1.5 SD below the normative mean. Speech and attention scores did not correlate with any M-ABC2 scores. Differences in language scores relative to peers were not significant when IQ was included as a covariate. Only four children did not display an impairment on speech or attention measures.

Discussion and conclusion

Speech motor and attention impairments were highly prevalent in children with DCD, but were not associated with poorer generalised motor coordination skills, suggesting independent neural correlates. Overall, our results confirm the high prevalence of co-occurring difficulties in children with DCD, particularly in the domain of executive functions. Persistent difficulties in speech motor control have not been highlighted in previous studies. Children who meet diagnostic criteria for DCD are at risk of additional difficulties in speech motor control and executive functions. We suggest that assessing these skills may be beneficial. These findings have important implications for potential support and adjustments for children with DCD both at school and at home. They are also important to disseminate to families and educators, who may not be aware of potential difficulties beyond motor skills in children with DCD.

Keywords: neuropsychology, speech, DCD, executive functions
Academic achievement in children with Developmental Coordination Disorder: the role of executive function

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Background and aim

Developmental coordination disorder (DCD) impacts on school productivity and success. However, it is not clear whether difficulties in children with DCD extend to all areas of academic achievement, and it has not been investigated whether children with motor difficulties without a DCD diagnosis experience similar academic problems. Furthermore, poor executive function (EF) skills, identified in children with DCD, may be important in explaining academic underachievement. The aim of the current study is to investigate a range of academic skills in children with poor motor skills, with and without a diagnosis of DCD, taking into account the contribution of EF.

Method

7-11 year-old children with DCD (n=17), children with motor difficulties without a diagnosis (n=32), and typically developing children (n=41), were assessed on measures of motor skills, language, and intellectual ability, as well as a comprehensive battery of EF across verbal and non-verbal domains of executive-loaded working memory, cognitive flexibility, planning, fluency and response inhibition. Two years later, participants were assessed on standardised measures of reading, spelling and mathematics. Multiple regression analyses were conducted to compare academic achievement across groups. Intellectual ability scores and composite scores of verbal and nonverbal EF respectively were included in the analyses.

Results

Academic abilities of children with motor difficulties without a diagnosis were similar to those demonstrated by typically developing children across all domains. Children with a diagnosis of DCD also performed as accurately as their typically developing peers on measures of reading and spelling, however, they had significantly poorer scores on the test of mathematical ability. Mathematical performance remained significantly poorer for children with DCD compared with typically developing children when verbal and nonverbal EF skills were taken into account in the analyses.

Discussion and conclusions

Academic achievement in children with DCD may be as expected based on chronological age and intellectual ability in areas of reading and spelling. However, these children may have specific difficulties with mathematics. There was no evidence that mathematical difficulties were related to EF problems, hence cognitive mechanisms other than EF may underlie numerical difficulties in children with DCD.

Keywords: Executive Function, Academic Achievement
What do detailed motor and non-motor profiles of children with DCD tell us about motor progression over time?

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Background and aim

Children with DCD have difficulty in the development of motor coordination and with learning new motor skills. Empirical and professional evidence suggests that they differ from typically developing children but also suggest that they are heterogeneous in nature. Studies have used different cut off points for motor impairment and yet little is known whether children’s motor progression differs for these different cut offs. This paper is part of a larger ecological project focusing on the characteristics of children with DCD. Aim of this study is to investigate the characteristics of children with different severity of motor ability and compare their motor progression over time.

Method

Children aged 7-14 years (M=10.07, SD=1.66, 85.3% boys) were recruited (n=34) from a mainstream school population and detailed profiles were compiled including IQ, SES, SEN status, family history, attention difficulties (SNAP IV), and language and communication difficulties (CCC2). DSM-5 criteria were applied to identify children with DCD (n=17). Repeated motor measurements were taken using MABC2 three times over 2 years.

Results

The children were categorized according to motor ability: less than or equal to 5th percentile, 6-16th percentile and greater than or equal to 25th percentile on MABC2. The children in the lowest motor ability group had distinct characteristics; lower IQ and 90% had associated characteristics (AC) of 2 or more developmental disorders. Repeated measures ANOVAs revealed significant differences between their motor performance and the other groups both at baseline and over time (p <.001). Post hoc analyses revealed stable, persistent and poor motor performance in the lowest group while the other two groups were more variable over time.

Discussion and conclusion

Children in the lowest 5th percentile of MABC2 appeared to have special characteristics in motor and non-motor domains. They had stable poor motor performance, lower IQ and greater likelihood of 2 ACs. These were different to both typically developing children and to children with milder motor impairment. Our results point the way to differential intervention according to the nature and severity of the characteristics in both the motor and non-motor domains.

Keywords: longitudinal, DCD profiles, outcomes
Emotional and Behavioral Problems in 4- and 5-year old children with and without DCD

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Background and aim

An increased prevalence of psychosocial and behavioural conditions has been observed in youth and adolescents with DCD. The majority of research examining the relationship between motor skill proficiency and psychosocial problems has focused on older children and adolescents.

Aim: To examine the relationship between motor skill proficiency and emotional and behavioural problems among pre-school age children with DCD to help determine how young children are when more severe problems begin to emerge (ie, symptoms meet clinical thresholds) and the prevalence of comorbidity.

Method

Children 4 to 5 years of age (n=589) from the Coordination and Activity Tracking in CHildren (CATCH) study were divided into two groups: at risk for DCD (rDCD; n=288) and typically developing (TD; n=301). Inclusion in the rDCD group required a score at or below 16th percentile on the Movement Assessment Battery for Children-2. Emotional and behavioral problems were assessed using the Child Behaviour Checklist (CBCL) 1.5 to 5 year parent-report questionnaire. CBCL data were scored using the CBCL DSM IV syndrome scales as well as the DSM V revised scale scoring.

Results

Seven children had missing or incomplete data on the CBCL and were excluded from the present analysis, leaving 582 participants. The mean age was 5.0 (SD 0.6) years and 57% of children were male (TD: 48% male, DCDr group: 67% male). After adjusting for sex, rDCD children scored significantly higher on all CBCL DSM-IV syndrome scales, all DSM-V scales, and all three summative scales. They were also significantly more likely to score at or above the DSM-IV clinical threshold on anxiety, withdrawn, emotionally reactive, aggression, ADHD, internalizing, externalizing, and total problems; and above the DSM-V thresholds on depression and autism. In addition, rDCD status was associated with a higher probability of meeting criteria for one, two, or more disorders in an ordinal logistic regression model.

Discussion and conclusion

This is the largest study done to date that has examined the relationship between motor coordination difficulties and emotional and behavioural problems among preschool age children. These results indicate that the severity and prevalence of psychosocial problems may be greater than previously thought among preschool age children with rDCD, suggesting interventions should begin at much earlier ages. Preschool children with rDCD have more parent-reported emotional and behavioural symptoms, and are more likely to be above the clinical threshold on a wide range of psychosocial problems and meet CBCL criteria for multiple conditions than their TD peers.

Keywords: Psychosocial and behavioural conditions, Young children
Cumulative Perinatal Risk Factors and Developmental Coordination Disorder (DCD) in Young Children

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Background and aim

Developmental Coordination Disorder (DCD) is a prevalent, neuro-developmental condition, affecting approximately 5-6% of children (American Psychiatric Association, 2013). DCD is primarily characterized by impairments in both fine and gross motor skills, resulting in deficits in overall motor coordination and activities of daily living (Visser, 2003). Although the etiology of DCD remains uncertain, studies have shown that perinatal risk factors may have an effect on the likelihood of a child developing DCD (Hua et al., 2014). While there is a growing body of literature demonstrating that perinatal risk factors such as alcohol exposure (Landgren et al., 2010) and smoke exposure (Hands et al., 2009) in utero are correlated with DCD diagnosis, there is limited empirical research on the cumulative effect of multiple perinatal risk factors. The purpose of this study was to examine the effect of cumulative perinatal risk factors on the development of DCD in young children.

Method

This study investigated the number of perinatal risk factors children with and without DCD had prior to birth (N=592, pDCD=291). Children were assessed on motor proficiency and six perinatal risk factors were obtained through a parent survey: (1) alcohol exposure in utero, (2) smoking exposure in utero, (3) gestational diabetes, (4) weight concerns, (5) high blood pressure and (6) other, unspecified medical conditions.

Results

A multinomial logistic regression revealed that the odds of a child having DCD are significantly higher with a greater total number of perinatal risk factors, after adjustment for mother’s age at child’s birth, child’s sex, child’s age, marital status and approximate current household income (OR=1.48, p=0.01).

Discussion and conclusion

These findings warrant further investigation into whether or not certain perinatal risk factors are more strongly linked to DCD than others. Furthermore, these findings may provide additional insight for women on prenatal care and enhance their knowledge on the risk factors for a child developing DCD later in life.

Keywords: prenatal care, motor coordination, risk factors
Developmental Coordination Disorder in mainland China: an analysis of prevalence and risk factors

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Background and aim

It has only been in the past decade that DCD has started to be recognized in the Chinese healthcare and education system. Although efforts are currently underway to determine the prevalence of DCD in mainland China, to date there are no reliable data that indicate the national magnitude of the disorder. The collection of data on a large representative sample of children provided the opportunity to examine a range of risk factors associated with motor impairment in young children. The aims of this study were: i) to investigate the prevalence of DCD in Chinese children with a national representative sample in mainland China; ii) to analyze perinatal, personal and environmental risk factors contributing to motor impairments in Chinese children; and iii) to provide instructional guidance to determine the clinical diagnostic criteria of DCD in the Chinese population.

Method

The Movement ABC-2 Test was administered to a stratified sample of 2185 children (1143 boys; 1042 girls) aged 3-10 years representative of the population in mainland China. Various cut-off points were considered to identify those with a motor impairment. Questionnaires on movement and coordination performance of the children, and others on the family and school environment were completed by teachers and parents. Prenatal and perinatal clinical information was also gathered from the parents. Associations between a range of perinatal, personal and environmental factors and motor impairment were examined by regression analyses.

Results

Prevalence figures vary according to the cut-off point selected to denote motor impairment. Some risk factors for motor difficulties (e.g., gestational age, pathologic jaundice, time spent in outdoor activities, SES and sibling status of the family) were identified.

Discussion and conclusion

Methods for determining the prevalence of DCD in mainland China will be considered and explanatory models for the risk factors identified in this study will be proposed. The presentation will also outline the challenges that lie ahead as the education and healthcare system in China struggles to address the needs of children identified with DCD. This study provides a first analysis of children’s motor development and motor impairments in mainland China with a national representative sample. The results demonstrate the need to use local norms for Chinese children. The broad database of perinatal, personal and environmental variables gathered as part of this study will enable a detailed examination of the mechanisms of motor development.

Keywords: Assessment, Risk Factors, Mainland China, Prevalence of DCD
Profile of Early Developmental Milestones in Children with DCD

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Background and aim
DCD is a neurodevelopmental disorder that is characterized by child’s inability to perform daily tasks, learn motor skills, and succeed at school. Evidence suggests that the onset of DCD is in the early developmental period and that children with DCD may have language deficits and delayed motor milestones. We aim to identify children at risk of Developmental Coordination Disorder (DCD) through a retrospective study of early speech, language and motor developmental milestones of children who were later diagnosed with DCD.

Method
Data will be extracted through a retrospective chart review of 200 children (aged 4-15 years) seen from January 2014 to December 2018 at the DCD Clinic at Sunny Hill Health Centre for Children in Vancouver, British Columbia. Consent was previously obtained from the parents and assent from children aged 7 years and older to have their clinical data entered into the database. Data include: (1) history of speech difficulties (e.g., speech delay, problems with articulation, verbal/oral apraxia, other); (2) history of language difficulties (e.g., expressive language delay, receptive language delay, difficulty with pragmatic language); (3) when common gross motor milestones (e.g., sitting, crawling, walking) were attained; (4) other co-occurring diagnoses (e.g., speech and/or language disorders, learning disabilities, attention deficit hyperactivity disorder, autism spectrum disorder). The database also includes scores on the following measures: Movement Assessment Battery for Children – Second Edition (MABC-2), the Developmental Coordination Disorder Questionnaire (DCDQ), the Kaufman Brief Intelligence Test-2 (KBIT-2), and the Conners-3 ADHD Index-Parent.

Results
We will: (1) describe the prevalence of early speech and language delays in children with DCD; (2) determine the number of children with DCD who achieved common gross motor milestones (e.g., sitting, crawling, walking) on time compared to the number of children who were slightly delayed or late in achieving these milestones; and (3) explore whether other co-occurring conditions may be related to delayed speech and/or language and motor milestones.

Discussion and conclusion
Results will indicate if early speech, language, and gross motor developmental milestones are commonly associated with DCD and/or common co-occurring conditions, which may provide an avenue for early identification of children at risk for DCD. This information will be helpful for therapists and physicians when considering a child’s developmental history in the context of a DCD diagnosis.

Keywords: DCD, speech/language delay, motor milestones
Developmental Coordination Disorder before the age of three: a longitudinal retrospective study

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Background and aim

Guidelines from the European Academy of Childhood Disability suggested not to diagnose DCD before the age of 3y. This study investigates to what extent concerns about movement quality before 3y, are associated with a diagnosis of DCD after the age of 3.

Method

Data from 503 children, assessed in the Centre of Developmental Disabilities Ghent, have been collected (data from 1507 assessments). Inclusion criteria were (1) to be assessed at least once before and once after 3y; (2) no medical diagnosis known to have an impact on motor development; (3) an IQ above 70.

Motor assessments before 3y were categorized in assessments between 0-6m (N=223), 6-12m (N=221), 12-18m (N=111) and 18m-3y (N=440) and screened for terms describing atypical movement quality. By consensus, these terms were organized in 13 different categories, dichotomously scored as present or not. The presence of the different qualitative terms was also combined to calculate one continuous variable, representing the number of concerns regarding movement quality. The AIMS and Movement-ABC-2 scores were collected.

Results

The age at the last assessment varied between 3y 0m and 10y 3m with a mean age of 5y 0m (SD = 1y 2m). At that time 157 children (31,4%) were diagnosed with DCD and another 89 children (17,7%) were at risk for DCD. The Spearman correlation coefficient between the AIMS categories and the M-ABC-2 scores was .162 (p = .037) between 6-12m; .465 (p <.001) between 12-18m and not significant between 0-6 months. The Pearson correlation coefficient between the continuous variable ‘movement quality concerns’ and M-ABC-2 scores was -.256 (p<.001) in the age group 0-6m, -.271 (p<.001) at 18m-3y and was not significant at 6-12m and 12-18m. Bivariate logistic regression analysis by age group, with DCD (or at risk) versus no DCD as outcome variable and the qualitative categories, gender and prematurity as factors, revealed several significant associations. The best model has been identified for each age group. Between 0-6m the model contained gender, prematurity, asymmetry, dissociation and hypertonia; between 6-12m: gender, hypotonia, control and dissociation; between 12-18m: gender and asymmetry and between 18m-3y: gender, hypotonia, control, balance, coordination and hypertonia. The association between the AIMS scores and a diagnosis of DCD could not be established.

Discussions and conclusion

Observation of deviant movement quality in children before 3y is associated with a diagnosis of DCD after the age of 3 and is an indication for follow-up of these children.

Keywords: prediction, movement quality, early signs
Poor feeding at four months corrected age is predictive of DCD and other neurodevelopmental impairments in infants born extremely preterm

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Background and aim

To determine the relationship between feeding behaviors of extremely preterm infants at 4 months corrected age (CA) and Developmental Coordination Disorder (DCD) at 4.5 years. Infants born preterm are at high risk for neurological and developmental impairments, including DCD. While it is known that early motor performance of preterm infants is a significant predictor for DCD at 4.5 years, there is a need to identify additional early predictors for DCD to allow early identification and intervention for infants at high risk.

In this study, we investigated the relationship between early feeding behaviours at 4 months CA and DCD diagnosis at 4.5 years among infants born extremely preterm [born ≤ 29 weeks gestational age (GA)] or extremely low birth-weight (ELBW: ≤1500g).

Method

Using a retrospective longitudinal cohort design, we investigated early feeding behaviors of 263 infant born extremely preterm (M = 25.9 weeks GA, SD = 1.84 weeks) or ELBW (M = 808g, SD = 203g) and developmental outcomes at 4.5 years: typical motor development (TMD, n = 146), with/at risk for DCD (n = 61), and other major neurodevelopmental impairment (NDI: cerebral palsy, autism spectrum disorder, global developmental delay, n = 56). Feeding behaviors were assessed by parent report and informal clinical observation, and motor outcomes were determined using the Movement Assessment Battery for Children; DCD was defined as ≤15th percentile. We used Chi-Square to determine relationship between feeding behavior and developmental outcomes, and ordinal logistic regression to examine whether early feeding problems predicted developmental outcome (controlling for GA, birth weight, Apgar score, and days on ventilation).

Results

Preliminary results indicate that developmental outcome at 4.5 years differed significantly (p < .001) by feeding behaviors at 4 months CA: infants classified as "poor feeders" at 4 months were more likely to be diagnosed with DCD (33.3% of poor feeders) or with NDI (53.3%) at 4.5 years, compared to infants who were classified as normal feeders (21.9% DCD and 17.2% NDI). Significant group differences were found between TMD and DCD, and between TMD and NDI (p < .001), but not between DCD and NDI (p = .113). Feeding behaviors at 4 months were a significant predictor of developmental outcomes at 4.5 years (p = .014). GA and ventilation also predicted developmental outcome (both p < .001)

Discussion and conclusion

Poor feeding in infancy is an early risk factor for DCD and other neurodevelopmental conditions and is worthy of further investigation.

Keywords: preterm infants, feeding, DCD
Are perceived and actual motor competence associated in young children? National data of 5- to 7-year old children on a continuum of motor functioning

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Background and aim
Perceived motor competence (PMC) reflects child’s own expectations and conviction of being skilled. It is not well-known how standardized motor tests and PMC correlate in children on a continuum of motor functioning. The first aim was to investigate the proportion of 5- to 7-year old children who were at the lowest 15th and 5th percentile in a nationally representative Finnish sample, as part of the ‘Skilled kids’-study. Secondly, we studied how these children evaluated their motor competence and thirdly, if there was a correlation between their perception of, and actual motor competence.

Method
The sample consisted of 441 children (n=229; 52% boys) (mean 6.2 years, SD=0.64). PMC was measured with the pictorial scale of Perceived Movement Skill Competence for Young Children and actual motor competence with Test of Gross Motor Development -3rd edition and Körperkoordinationstest Für Kinder (KTK). Children were classified into lowest 5th and 15th percentile based on TGMD-3 and KTK total scores. The correlations between actual and PMC were analysed with adjustment for age and sex.

Results
For the TGMD-3, 68 children scored below 15th percentile, and 23 below 5th percentile. For the KTK, 61 children scored below 15th percentile and 21 below 5th percentile. Of these, 28 children (girls n = 15; 53.6%, mean age 5.83 yrs; SD .60) scored below 15th percentile in both tests. There were six children (mean age 5.34 yrs; SD .26) in the lowest 5th percentile for the TGMD-3 and KTK and they were mostly boys (n = 4; 66.7%). Children evaluated their actual skills to be higher than their actual motor competence level was. PMC was not correlated with the TGMD-3 nor the KTK in the total group, the 5th, and 15th percentile groups.

Discussion and conclusion
There were 1.3% of children who belonged to the 5th percentile group and 6.3% children to the 15th percentile group in both motor tests. Although TGMD and KTK are not screening tests, these children might be at risk of motor coordination problems. Most of the children had high PMC and no correlations between perceived and actual motor competence were found. However, since PMC moderates engagement in physical activity, a positive PMC might provide a good foundation for additional motor skills practice for children at risk of motor coordination problems. Furthermore, the success of motor skill interventions in young children depends on proper understanding of the complex multidimensional correlates of PMC.

Keywords: perceived motor competence, motor skills, actual motor competence, children
Identification of children at risk for DCD in European-French countries: A collaborative project

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Background and aim
To adapt validated screening tools to identify children at risk for DCD in European-French-speaking countries. The identification of children at risk for DCD is critical for preventing the consequences of the condition on children’s autonomy in school and daily activities and sense of self-efficacy. To that end, parental reports have been shown to be useful and are better captured through the use of questionnaires. Since most valid screening instruments are available only in English or for a Canadian-French population, it is necessary to undertake a cultural adaptation process to ensure these instruments can be used with confidence among a European French-speaking population. The European-French cross-cultural adaption of the Developmental Coordination Disorder Questionnaire (DCDQ’07) for children between 5 and 15 years old and of the Little DCDQ for children aged 3 to 5 years was undertaken in French-speaking Switzerland and France following common standardized protocols.

Method
Following the international standard for cross-cultural adaptation (Beaton et al., 2000), the DCDQ’07 (Wilson et al., 2009) and Little DCDQ (Rihtman et al., 2011) were translated and their psychometric properties tested on both a community and a clinical sample comprising children from both countries. The MABC-2 (Henderson et al., 2007) was used to assess the convergent and predictive validity. The assessments of the validity of the DCDQ-FE and LDCDQ-FE were conducted using the MABC-2.

Results
Results showed that the DCDQ-FE and Little DCDQ-FE demonstrate satisfactory reliability. Both questionnaires scores related to the MABC-2 performances. Furthermore, for the DCDQ-FE, predictive validity was good with a sensitivity and specificity of 85.0% and 81.6% respectively, using a cut-off at 56. Results for the Little DCDQ-FE were less clear, in particular for 3-year-old children for whom the predictive validity was not significant.

Discussion and conclusion
The DCDQ-FE and Little DCDQ-FE are easy to understand and quick to administer questionnaires. Their psychometric properties have been found to be excellent to good. They can be used in a European French-speaking population to identify children at risk for DCD. For the youngest children, for whom the predictive value is not satisfactory, referring to the sample mean score and distribution is recommended. Collaborative projects are an effective and essential solution when large and varied samples are needed to examine linguistic and cultural adaptation as well as psychometric properties of translated instruments.

Keywords: identification, questionnaire, Developmental coordination disorder, validation
Consistency between teacher and parent questionnaires and performance on the Movement ABC-2 in 4-10 year-old Chinese children

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Background and aim

The Movement ABC-2 Checklist and DCDQ are designed to help identify children who have everyday life movement difficulties. Teachers and parents have knowledge of children’s daily motor performance, yet may make different judgements about the levels of competence observed at school and home. There is little existing information on the consistency between teacher and parent reports using these tools. The aims of the current study were: i) to investigate the consistency between teacher and parent reports of children using the Movement ABC-2 Checklist and the DCDQ; ii) to examine associations between different respondents on children's motor performance across different ages; iii) to examine concordance of teacher and parent ratings with results from the Movement ABC-2 Test.

Method

The Movement ABC-2 Test was administered to a stratified sample of 1295 children aged 4-10 years representative of the population in mainland China. Children with a standard score below 6 were identified as having movement difficulties. The Movement ABC-2 Checklist and DCDQ were completed by both teachers and parents on all children.

Results

The associations between teacher and parent reports on both questionnaires were examined by correlation and multiple logistic regressions. Teacher and parent reports using both the Movement ABC-2 Checklist and DCDQ showed a good correlation with Movement ABC-2 Test performance, except for the youngest age group. Parents generally showed a better agreement with the Movement ABC-2 Test performance compared to teachers. Both teachers and parents showed a good sensitivity to identify children with movement difficulties.

Further regression analysis suggested that motor difficulties identified by the teachers was associated with low scores on the Balance and Aiming & Catching components of the Movement ABC-2 Test; while motor difficulties identified by the parents was associated with low scores on Manual Dexterity, Balance, and Aiming & Catching.

Discussion and conclusion

The results indicated less consistency across different measures of motor performance in younger children, suggesting it is important to use a range of measures to identify a motor difficulty in the early years. The higher concordance between parent report and performance test results indicates that parents rate their child’s motor competence more accurately compared to teachers. Children with movement difficulties identified by different respondents showed different motor profiles. The results demonstrated a lack of consistency between teacher and parent reports using the Movement ABC-2 Checklist and DCDQ. A standardized performance test is recommended, especially when motor capabilities are tested in younger children.

*Keywords: Parent report, Movement ABC-2, Teacher report, DCDQ*
Validity of the Ages and Stages Questionnaire as a screening tool to identify young children with motor difficulties who require further physiotherapy assessment

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Background and aim

Approximately one in ten children under 5 years of age experience gross motor developmental difficulties that can interfere with everyday activity and participation. Many physiotherapists use the AIMS and/or NSMDA to examine performance of young children referred with motor difficulties. However, since assessment time is limited, a screening tool is needed to streamline access to therapists’ time. The ASQ-3 is a parent-completed questionnaire designed to screen development across a number of domains including gross motor function. Further motor assessment is recommended for children with ASQ-3-GM scores greater than two standard deviations (>2SD) below the mean for age. The ASQ-3-GM domain may be an appropriate screening tool for physiotherapists using the AIMS or NSMDA, however there is currently no evidence on the predictive validity of the ASQ-3 with these assessment tools. Aim was to determine if the Ages and Stages Questionnaire, 3rd Edition (ASQ-3) gross motor domain (ASQ-3-GM) is a valid predictor of motor performance on the Alberta Infant Motor Scale (AIMS) and the Neuro Sensory Motor Developmental Assessment (NSMDA) in children referred for physiotherapy assessment.

Method

We evaluated 84 children (50 males, 34 females) aged 0-5 years (24.9 months +/- 18.4) referred to a tertiary Child Development Service for concerns with motor skills. Parents completed the ASQ-3 questionnaire and then children were assessed using the AIMS (n=37) and/or NSMDA (n=74). Spearman’s correlation coefficients were calculated to determine relationships between the ASQ-3-GM domain with the AIMS and NSMDA. Validity of the recommended ASQ-3-GM ‘refer’ threshold (>2SD below age mean) was examined using frequency distributions and crosstab analysis.

Results

ASQ-3-GM scores correlated well with AIMS percentile rank (r=0.697, p<0.001) and NSMDA gross motor performance classification (r=-0.548, p<0.001). The ASQ-3-GM ‘refer’ threshold had 77% sensitivity, 91% specificity and 95% PPV to detect children scoring >/=10th percentile on the AIMS; and 57% sensitivity, 92% specificity and 97% PPV to detect children with at least minimal motor dysfunction on the NSMDA.

Discussion and conclusion

The ASQ-3-GM score is a valid predictor of AIMS percentile rank and NSMDA gross motor performance classification. The NSMDA has an added ability to detect children with minimal neurological, sensory and/or postural deficits associated with motor difficulties. Therapists can be confident that the ASQ-3-GM ‘refer’ threshold (scores >2SD below age mean) is a valid predictor of real gross motor difficulties in young children. Children scoring in this range will benefit from further physical assessment and targeted therapeutic intervention.

Keywords: AIMS, NSMDA, ASQ-3, Predictive validity
Dutch guideline on diagnosis and treatment of children with Developmental Coordination Disorder (DCD); EACD – DCD recommendations, adaptation and implementation process for the Dutch context

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Background and aim

Transition towards evidence-based approaches for children with Developmental Coordination Disorder (DCD) is an important aim of the Dutch DCD network. A Dutch DCD guideline pushes this process. The Netherlands Society of Rehabilitation Medicine gave the assignment to develop an evidence-based guideline based on the revised European Academy of Childhood Disability (EACD)-DCD recommendations. Aim was to increase awareness of DCD and early recognition of the symptoms of DCD an evidence-based guideline for assessment and intervention of children with DCD in the Netherlands was developed and implemented.

Method

An official interdisciplinary working group representing the Parent organization and different professional associations translated and adapted the EACD recommendations to the Dutch situation. Two new chapters on parent involvement and integrated care were added to this Dutch DCD guideline. The Dutch DCD network commented on a concept version and discussed on implementation during a network conference.

Results

The revised EACD recommendations were translated and adapted. Collaboration with all stakeholders including a parent organization resulted in two new chapters. The importance of family involvement was addressed and recommendations were made how this can be done based on literature and expert opinion. Recommendations on integrated care were formulated based on consensus. The Dutch DCD network and parent organization 'Balans' had an important role in the implementation process of the recommendations from the beginning. This results i.e. in an improved website which reached a lot of families according to the increased number of hits and contacts. The implementation process will also include informing teachers.

Discussion and conclusion

Translating and adapting the Revised EACD recommendations on DCD contributes to evidence-based practice for children with DCD in the Netherlands. Starting the implementation process from the beginning results in improvement in practice meaning early recognition and better care for children with DCD and their families.

Keywords: Guideline, Implementation, Adaptation, Dutch
Coping with DCD: differences between adults with DCD and parents

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Background and aim

Studies have shown that DCD has negative impacts on the lives of children growing up with the disorder, but less is known about factors mitigating such impacts, or how it affects parents. According to health psychology theories, these impacts could depend on factors such as 1/ perceived control over the disorder, and 2/ coping style. Studies are needed to address these research gaps, as results could be used to improve the wellbeing of individuals with DCD and their families. The aim of the present study was to assess the extent to which two groups (i.e. adults with DCD and parents of adults with DCD) differ in 1/ perceived impacts of DCD on life, 2/ perceived control of DCD and 3/ coping styles.

Method

Two groups of participants were recruited through online support groups: 87 adults with DCD (Mage = 34.52 years; SD = 12.05; 75% women) and 21 parents of adults with DCD (Mage = 54 years; SD = 7.16; 100% women). All completed anonymous online surveys assessing 1/ perceived DCD impact on life (Hagger & Orbell, 2003), 2/ perceived control over DCD (Hagger & Orbell, 2003), and 3/ coping (Carver, Scheier, & Weintraub, 1989).

Results

Findings revealed that, compared to the parents, adults with DCD reported lower DCD impact on life (t (103) = – 5.57, p < .000), and greater control over DCD (t (103) = 2.40, p = .018). In terms of coping, differences were found in acceptance, planning and active coping, in that adults with DCD reported significantly greater acceptance of the disorder (t (103) = – 2.03, p = .045), less planning (t (103) = – 2.41, p = .018) and less active coping (t (103) = – 2.00, p = .048), than the parents did.

Discussion and conclusion

Compared to the parents, adults with DCD felt that the disorder had less impact on life. They also felt more accepting and more in control of the condition and were less likely to engage in planning (e.g. thinking about what steps to take) or active coping (e.g. concentrating efforts on doing something about DCD). The present findings are significant as they suggest that lower coping scores from adults with DCD could actually be adaptive. If these scores are underlined by greater perceived control of the disorder, then adults with DCD may feel less of a need to engage in coping strategies.

Keywords: Control over DCD, Perceived impact of DCD, coping with DCD
Parenting stress of parents of children with Developmental Coordination Disorder

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Background and aim
Previous research suggests that parents of children with developmental disabilities report higher levels of parenting stress compared to parents of typically developing (TD) children. Furthermore, more than half of parents of children with these disabilities experience levels of parenting stress within the clinical range. However, there is very little research on whether parents of children with Developmental Coordination Disorder (DCD) also experience high levels of parenting stress, and, if so, the factors that contribute to this stress. This study had two aims: to determine whether a significant number of parents of children with DCD experience levels of parenting stress within the clinical range and to identify the factors that predict parenting stress in parents of these children.

Method
Ninety eight parents of children with a diagnosis of DCD between the ages of 5 and 12 completed five questionnaires measuring parenting stress, social support, parenting self-efficacy, the child’s behavioural problems, and severity of the child’s motor coordination problems.

Results
A large majority of the parents (71%) reported experiencing levels of parenting stress within the clinical range. The severity of the child’s behavioural problems and parenting self-efficacy were found to be significant predictors of parenting stress.

Discussion and conclusion
These findings suggest that, similar to parents of children with other developmental disabilities, parents of children with DCD can experience high level of stress associated with being a parent. Specifically, factors such as the child’s behavioural problems and the parent’s self-efficacy may play a role in the parents’ levels of stress. These findings contribute to the understanding of the experience of parents of children with DCD and highlight that these parents may be a vulnerable group which requires support from professionals to help them cope with the demands of taking care of their children. The management of behavioural problems and the parent’s self-efficacy should be considered in the development of tailored interventions for these parents.

Keywords: Parenting stress, Parents, Developmental Coordination Disorder
Parents’ perceptions of received care and Empowerment of parents of children with Developmental Coordination Disorder (DCD)

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Background and aim

To identify relationships between aspects of processes of care and feelings of empowerment in parents of children with Developmental Coordination Disorder (DCD). Enhancing parent empowerment, the feeling of being in control over decisions and actions that effect the wellbeing of their child, is important in increasing the ability of parents to support their child and cope with its problems after receiving the diagnosis. In the present study we will analyze the relation between different aspects of processes of care and feelings of empowerment among parents of children with DCD.

Method

Parents of children with a DCD diagnosis filled in the Family Empowerment Scale (FES) and the Measure of Processes of Care (MPOC-NL) self-report questionnaires. Spearman's rho will be used to analyze relations between the MPOC- and FES subscales. Multiple regression was used to identify the the most important predictors for empowerment.

Results

Parents (96.4% mothers) of 83 children (78.3% boys) with DCD completed the questionnaires. Preliminary analyses show that on average, the participants often felt empowered about taking care of their family. Parent’s perceptions of the extent to which professionals provided specific information about their child, were enabling and showing partnership, and provided coordinated and comprehensive care for the child and family were significantly related to their degree of experienced empowerment both with regard to their family and with regard to their child’s services. Multiple regression entering all five MPOC subscales showed that the scale Enabling and Partnership was the sole significant predictor for empowerment. Within this scale the items ‘provide opportunities for you to make decisions about treatment’ and ‘listen to what you have to say about your child’s needs for equipment, services, etc.’ seem the most important in predicting empowerment.

Discussion and conclusion

Preliminary analyses suggest that it is the extent to which parents perceive to be actively involved in their child’s care, particularly in decision-making and in eliciting parental input, concerns and opinions, by health care professionals that is related to feelings of empowerment.

Keywords: Family Empowerment, DCD, care-giving, Parent Empowerment
impACT for DCD: Findings from a large-scale survey examining the challenges of raising a child with DCD in Australia

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Background and aim

Despite decades of research demonstrating the functional and emotional impact of DCD, the disorder remains under recognised and inconsistently supported. To raise awareness and change policy, large-scale evaluation and translation of the challenges children and families encounter is required. The primary aim of the present study was to initiate this process in Australia by evaluating family perceptions of issues surrounding diagnosis, access to therapy, educational support, along with the physical, mental and financial impacts.

Method

The impACT for DCD survey was designed in collaboration with parent, teacher and clinical service reference groups, along with DCD Australia and Knowledge Translation Australia. Completed by primary caregivers of children/adolescents aged 5-18 years with DCD or similar diagnoses, the survey consists of >150 questions clustered across five impact domains: 1. diagnosis, 2. activity and participation, 3. education, 4. therapy and intervention, 5. social and emotional. The survey was launched in Australia in February 2018 and will remain open for 12 months.

Results

To date, the survey has been completed by almost 400 families. Preliminary findings highlight the enormous challenges families encounter, especially obtaining a diagnosis, support at school, socially and emotionally. Even though most families (>80%) were concerned before 4 years of age, average age of diagnosis was close to 6. Families (>85%) reported that receiving a diagnosis was helpful, however diagnostic labels varied considerably. At school, families reported that teachers were not familiar with the disorder and 1 in 3 children received no assistance or allowances. 86% felt their child’s movement difficulties were impacting their ability to reach their potential at school and 1 in 4 reported their child did not enjoy school. Even though functional and physical impact were highlighted, of particular concern is the social and emotional impact, with 91% of families concerned about their child’s social and emotional health. Questions from the Strengths and Difficulties Questionnaire (SDQ) showed 95.8% of children were in the abnormal range for peer problems and 64.8% for emotional difficulties. Accessing therapy is challenging for families; 56% receive no financial support, 1 in 2 families reporting that accessing therapy caused financial strain, and 58% reporting they felt their child had not received sufficient therapy.

Discussion and conclusion

This critical advocacy data demonstrates systemic lack of awareness of DCD, and highlights the need to further explore how to best support children with DCD, particularly in key target areas surrounding diagnosis, education, early intervention, health and wellbeing.

Keywords: impact, knowledge translation
Adaptive balance responses of children with developmental coordination disorder

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Background and aim

Developmental coordination disorder (DCD) is presented in approximately 6% of school-aged children. Impaired postural control (balance) is common among children with DCD and it results in falls and injuries. Adaptive balance response is the ability to modify sensory and motor systems in response to changing task and environmental demands to prevent an individual from falling. It is a very important motor ability but has not been explored in children with DCD so far. This study aimed to compare the adaptive balance responses between children with DCD and those with typical development (TD).

Method

A cross-sectional and exploratory study was carried out. Both children with and without DCD were recruited from the local community. The participants’ adaptive balance performance was assessed using an adaptation test (ADT) on a computerized dynamic posturography machine. Five testing trials were performed for both ADT toes up and toes down platform inclination conditions. The sway energy score of each trial and average sway energy score obtained during both toes up and toes down conditions were compared between the DCD and TD groups. This study was partially supported by a GRF grant from the Research Grants Council of the Hong Kong Special Administrative Region, China (17658516). Approved by Human Research Ethics Committee (EA291214) of the University of Hong Kong.

Results

52 children with DCD (mean age ± standard deviation = 7.08 ± 1.27 years) and 52 children with TD (mean age ± standard deviation = 6.77 ± 1.14 years) participated in the study. The ADT sway energy score of trial 1 during toes up condition in the DCD group was significantly lower (faster) than TD group (mean difference = 16.02, 95%CI = 4.05, 27.98, p = 0.009). No significant between-group differences were noted in all other outcome variables. Within-group analysis revealed that TD group demonstrated significantly lower (faster) ADT sway energy scores across trials 1 and 2 in both toes up (p = 0.005) and toes down conditions (p = 0.001), but these changes were not found in the DCD group.

Discussion and Conclusions

Children with DCD demonstrated better balance performance during toes up platform inclination condition. However, adaptation in balance response was not noted in children with DCD as in children with TD. Dynamic balance training in children with DCD should include various task and environmental demands to improve their adaptive postural responses.

Keywords: adaptive postural control, Dyspraxia, rehabilitation
**Coordination in children with DCD during a novel ’pedalo’ task**

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**Background and aim**

To examine how children with DCD coordinate their body while performing a novel pedalo task. 'Coordination' involves the organisation of different elements of a complex activity to enable them to work together efficiently. Although central to the term 'DCD' this has received little attention in research. Studies which have examined coordination skills in children with DCD demonstrate they generally show difficulties when asked to produce rhythmic coordination patterns in tasks requiring self-paced finger tapping movements (Volman & Geuze, 1998), finger tapping to a beat (Whitall et al., 2008) and clapping while marching to a beat (Whitall et al., 2006). Elders et al. (2010) considered the coupling of the head, torso and hand in a pointing task and found that the general coordination pattern was the same across groups but that children with DCD failed to reliably couple body segments. Astill & Utley (2006) considered the coupling of multiple limb segments in a catching task and demonstrated that children with DCD showed a ‘freezing’ of degrees of freedom in the upper limbs which was not apparent in age-matched controls. These findings highlight the coordination difficulties of children with DCD, but they have not considered whole body tasks, nor how coordination change with practice.

**Method**

Nine children with DCD (aged 11-16 years) and nine age and gender-matched typical children moved along a 10m walkway on a pedalo. Movements were recorded using a VICON system which tracked 16 reflective markers attached to the head, neck, shoulders, elbows, wrists, hips, knees, ankles and feet. Performance was measured by the overall speed of movement and the coefficient of variance of speed. Coordination of body segments was determined using principle component analysis with consideration of change over the course of 20 practice trials.

**Results**

The way in which children with DCD coordinate their limbs, how this changes over time and links to overall task performance will be explored. A comparison to controls will also be made.

**Discussion and conclusion**

Results will be discussed in light of previous findings and directions for future research suggested. This study is one of the first to consider change in coordination dynamics during a novel task in children with Developmental Coordination Disorder. Therefore, it will provide an important base onto which future studies can be built.

*Keywords: Skill acquisition, Children, Coordination dynamics*
Developmental Coordination Disorder: What can we learn from mice?

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Background and aim

To create an animal model to better understand the phenotypic presentation and genetic basis of Developmental Coordination Disorder (DCD). DCD is a neurodevelopmental disorder of unknown etiology; however, recent studies suggest a genetic basis to DCD, warranting further investigation of the underlying molecular and neurodevelopmental mechanisms.

Method

We have designed a set of tasks with resemblance to human symptomology of DCD. Recombinant in-bread (RI) lines of mice, twelve BXD strains and parental strains C57BL/6J and DBA/2J, underwent a neurodevelopmental battery postnatally to evaluate the achievement of sensorimotor milestones. We then conducted a series of motor coordination and motor learning tests.

Results

To date, we have found significant strain effects for all measures, indicating that the unique genetic background of each strain plays a role in the measured behavioral performance. Although the motor milestones fell within the typical age range, BXD27 lagged behind its counterparts. An open field test served as an indicator of spontaneous locomotor activity and anxiety levels. It was found that BXD27 mice travelled the least distance (2285.58 ± 238.38 cm) and were the most sedentary (58% of total time), indicating low locomotor activity. BXD27 also spent the least amount of time in the center of the field (5% of total time) showing signs of increased anxiety-like behavior. Furthermore, BXD27 demonstrated poor motor coordination, balance, and motor learning over consecutive days of testing on the rotarod. BXD27 initially showed poor to moderate latency to fall from the rotarod (90.26 ± 5.62 secs), but they had relatively poorer motor learning abilities when final testing day was compared to baseline measures (+17.43 ± 6.10 secs). In the upcoming months, brain imaging will be done to understand the basis for poor motor coordination and motor learning in BXD27. This strain is known to have smaller cerebellar volume, which we are currently examining in a human cohort of children with DCD. Additionally, behavioural results from these strains of mice will be used to identify candidate genes using quantitative trait loci analysis.

Discussion and conclusion

BXD27 presented with the most DCD-like phenotypes. Robust phenotypes in mouse models hold great promise as clinicians explain to families a possible genetic cause of DCD and the heterogeneous nature of the disorder.

Keywords: Genetics, Neuroimaging, Animal Model, Motor Learning Behaviour
Motor learning in DCD: action observation, motor imagery, implicit learning?

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Background and aim

Children with Developmental Coordination Disorder (DCD) exhibit compromised motor learning and motor performance compared to their peers. In the last decade, a large number of studies were undertaken to search for the underlying mechanism of DCD. From recent reviews of the literature by Adams et al. (2016) and Wilson et al (2017) it was evident that behaviourally, anticipatory planning and automatization are the most common aspects that are deviant in DCD. These behavioural observations point to a deficit in the internal model of motor control. Internal modelling is an important construct in cognitive neuroscience models of motor control. They use a copy of motor command signals to predict future states of the moving limb[s]. This process ensures smooth movement performance based on feedforward information. In contrast, a deficit in the internal model prompts a greater reliance on slower feedback-based control and compensatory strategies, leading to the typical motor control and learning observed in DCD. Based on these insights new intervention programs have been proposed, amongst which implicit learning, action observation learning, and motor imagery.

Discussion and conclusion

In this presentation I will elaborate on the current state of evidence of these interventions and will also highlight the challenges for implementation of these interventions.
Gaze behaviour during daily tasks in young adults with Developmental Coordination Disorder

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Background and aim

A number of studies have revealed deficits in basic oculomotor control in children with Developmental Coordination Disorder. For example, reduced spatial accuracy of the saccades or less performant smooth pursuit. As oculomotor control is often tested in constrained laboratory environments, it is less clear to what extent these deficits hamper coordination of daily life tasks with less stringent temporal constraints. To this end, the present study explored gaze behaviour in young adults with Developmental Coordination Disorder (DCD) and their typically developing counterparts in daily tasks.

Method

A sample of 10 young adults (age range: 20-23y) who had been diagnosed with DCD during childhood and 10 age and gender match controls was recruited. Gaze behaviour was assessed with eye tracking glasses (SensoMotoric Instruments, Teltow, Germany) while performing a fine motor control task, i.e. cup stacking, and a gross motor task, i.e. walking over cluttered terrain. The body kinematics were registered with a digital video-camera (Casio, Tokyo, Japan). Gaze behaviour (i.e. number and duration of fixations per area of interest), kinematics and eye-body/foot coordination were computed and compared across tasks and groups.

Results

Overall, individuals with DCD moved slower during both sequential movements, i.e. cup stacking and walking and different gaze strategies were observed in the two groups. In contrast to the control group, individuals with DCD rarely skipped fixation of a target during either task. The relative timing of eye and hand in cup stacking tended to indicate longer fixation times prior to the initiation of a hand movement in those with DCD. For walking, more fixations and longer dwell times (total duration of fixations) were found the majority of the targets (stepping stones) in individuals with DCD. The neurotypical individuals performed more and longer fixations towards targets 3 or more steps ahead.

Discussion and conclusion

These findings indicate that young adults with DCD adopt different gaze strategies to be able to move accurately in both the fine motor control and gross motor control task. These differences may be due to deficits in the oculomotor system. Alternatively, the behaviour of the individuals with DCD, may also reflect an increased reliance on foveal information and visual online control.
Investigating how prior knowledge influences perception and action in Developmental Coordination Disorder

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Background and aim

Developmental Coordination Disorder (DCD) is characterised by a broad spectrum of difficulties in performing motor tasks, in the absence of any physical or sensory impairment. It has recently been proposed that a selective deficit in sensorimotor prediction and feed-forward planning might underpin these motoric impairments. The purpose of this study was to use a naturalistic object lifting paradigm to investigate whether deficits in sensorimotor prediction might underpin the broad spectrum of difficulties individuals with DCD face when interacting with objects in their environment.

Method

We examined perceptions of heaviness and fingertip force application in children aged 8-12 years with DCD (n=48) and without DCD (n=53). We examined these measures in the context of the size-weight illusion paradigm, lifted objects which varied in their apparent, but not actual, weight. In typically-developing populations, these stimuli elicit a powerful expectation-based weight illusion, with the smaller objects feeling heavier than the larger object, as well as characteristic prediction-driven lifting behaviour with larger objects gripped and lifted with a higher rate of force than smaller objects.

Results

Overall, participants showed the expected perceptual and sensorimotor behaviours – small object felt heavier, and were initially lifted with lower rates of force, than large objects. We found no evidence for a difference in the magnitude of perceptual or sensorimotor effects between children with and without DCD.

Discussion and conclusion

Our results find no evidence to support the proposal that DCD represents a selective deficit in sensorimotor prediction and feed-forward planning, in a task which is appropriate for this population.

Keywords: dyspraxia, motor control, grip force, prediction
**Combined action observation and motor imagery improves eye-hand coordination in children with Developmental Coordination Disorder**

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**Background and aim**

The internal modelling deficit (IMD) hypothesis states that children with Developmental Coordination Disorder have difficulties using predictive models of action, leading to impaired planning and an over-reliance on slower feedback-based control. Mental simulation techniques have been proposed to target such deficits. Recent research has shown that the combined, and simultaneous, use of action observation and motor imagery (AOMI; e.g., instructing participants to observe a movement on video whilst imagining simultaneously the kinaesthetic feelings associated with the execution of the observed movement) promotes increased activity in the motor system and better behavioural outcomes, compared to the independent use of either technique. The aim of this study was to explore the efficacy of AOMI intervention for developing eye-hand coordination is children with DCD.

**Method**

Twenty children (13 male, 7 female) with DCD, aged 7-11 years (M = 9.0, SD = 1.45 years), were required to adapt to a visuomotor rotation task in which a cursor had to be guided to targets. Participants were randomly assigned to either an AOMI group (n = 10) who performed motor imagery of executing the 90° rotation task whilst simultaneously watching videos of a novice learning the same task; or a control group (n = 10) who watched an equal dose of educational video clips containing no human motor content. Both groups completed 20 blocks of one video observation followed by one physical practice trial. Pre and post intervention measures of task completion time (seconds), mean square error of the cursor path and eye-movement data was recorded pre and post intervention.

**Results**

A significant interaction, $F(2.41, 43.55) = 3.97, p = .02$, was found for completion time, indicating that the AOMI group was the faster of the two groups at post-test. A significant interaction was revealed, $F(2.04, 34.7) = 3.50, p = .04$, for gaze behavior, indicating that children in the AOMI group made more predictive, target-focused, eye-movements, compared to the control group (who primarily focused on the cursor as it moved). No significant differences were found in kinematic variables.

**Discussion and conclusion**

AOMI facilitated the development of optimal eye-hand coordination in children with DCD. Future research should explore the utility of AOMI interventions for activities of daily living and sports skills in this population.
Tired of DCD?

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**Background and aim**

Several reasons have been adduced to explain why children with DCD perform poorer on health-related fitness tests compared to typically developing (TD) peers. Some people may argue that children with DCD do not try hard enough, others think they give up easily or fatigue quickly. Many factors might determine the final score on fitness tests. These may include; (i) physiological states, (ii) physical qualities, (iii) specific task skills, (iv) psychological attributes, and personal traits. The intent of fitness testing is to quantify the child’s physiological state. Yet, most tests used in DCD research also tend to measure coordination, motor planning and anticipatory control depending on the skill used (e.g. running, hopping, cycling and jumping). Little research has examined the psychological and personal attributes that may limit performance in children with DCD, and if these are different from well-coordinated children.

To our knowledge, no study has examined the association between decay in intermittent sprinting time (fatigue) and heart rate under field-testing conditions. Due to the lack of an appropriate field-based test to measure fatigue, we developed the Child Repetitive Intermittent Sprint Performance (CRISP) test to measure anaerobic performance.

**Method**

To test if TD children (TDC; n=50) and those with DCD (<10th percentile on the MABC, n=50) were different in running time, decrement in running time (fatigue) and changes in heart rate (HR) over multiple sprints. The CRISP test, which involves six sprints over a 30m distance, with short recovery between each sprint was used.

**Results**

Anaerobic performance and power showed large differences between DCD and TD children. No difference was seen in fatigue-resistance. There was no indication from HR results that the two groups were less close to their estimated maximum performance.

**Discussion and conclusion**

Children with DCD are reported to have lower levels of physical activity, which increases their risk for future cardiovascular disease and diabetes. Therefore it may be valuable to identify reasons underlying their poor anaerobic performance for testing and intervention purposes.

*Keywords: anaerobic performance, sprint, power, fatigue*
Does meeting more or less DSM-criteria for DCD make a difference in anaerobic capacity and muscle strength?

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Background and aim
Most studies report lower levels of anaerobic capacity and muscle strength in children with Developmental Coordination Disorder compared to typically developing children, however some report contradictory findings. Reasons for these conflicting results could be due to differences in (1) age, (2) measurements used, (3) selection criteria of the groups. Both age differences and tool use have been studied (Li et al., 2011; Aertssen et al., 2016; Ferguson et al., 2014). A less researched reason is the heterogeneity between the participating DCD groups, in terms of inclusion criteria. This is important since most of the research studies looking at anaerobic capacity and muscle strength included a sample based on the result of a motor performance test (p-DCD) and seldom included children recruited from a treatment setting. We investigated if children selected via a population-based search for children with total scores ≤ 5th MABC-2 (p-DCD) differed from children with clinical DCD (clin-DCD) on anaerobic capacity and strength. The latter group was referred for treatment because their motor problems interfered with their daily activities to such an extent that the parent sought help for the child. If these children scored ≤ 5th MABC-2 and a pediatrician confirmed their diagnosis, they will be referred to as clin-DCD in this study.

Method
Fifty children (mean age 7.2 SD 1.5) were tested on the Functional Strength Measurement (8 items) and thirty-five on the Muscle Power Strength Test (anaerobic capacity test).

Results
Total MABC-2 standard score was lower in clin-DCD (mean 2.9, SD 1.6) than in the p-DCD group (4.6, SD 0.8). 44% of the clinical children scored below the 1st percentile, while none of the children in the p-DCD scored below the 2nd percentile. Distribution over gender was similar between groups (boys/girls; 70/30%). Notwithstanding these disparities, no significant differences were found between children meeting all 4 criteria of DSM-5 on anaerobic capacity and muscle strength and children in which only criterion A was confirmed. Trend (p 0.07) was seen for items lateral step up and running up and down stairs for the p-DCD group to perform better.

Discussion and conclusion
Children referred for treatment in our sample seem to have very poor scores on the MABC-2. Based on this small sample however, it seems that results from studies on anaerobic capacity and muscle strength obtained in p-DCD groups can be translated to clinical practice populations because performance on these tests seem very similar.

Keywords: anaerobic capacity, clin-DCD, strength, p-DCD
The importance of physical self-perceptions and their relationship with actual fitness in adolescents with low motor competence: Do they care?

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Background and aim

Although it is well documented that physical competence plays a crucial role in forming a healthy self-concept it is unclear how actual physical fitness is related to perceptions of physical competence in adolescents with low motor competence (LMC). Our major aim in this study was to examine the relationship between physical self-perceptions and fitness. In addition we also sought to understand the level of importance placed on sub-domains of physical competence.

Method

Thirty four adolescents with LMC aged 12 to 17 years (Mage =13.89 yrs, males = 25) were recruited. LMC was determined by the Neuromuscular Developmental Index (MAND test, McCarron, 1997). They completed the Children’s Physical Self Perception Profile (Eklund, Whitehead & Welk, 1997), which comprises six subscales; Sports Competence (SC), Physical Condition (PC), Attractive Body (AB), Physical Strength (PS), Physical Self-Worth (PSW) and Global Self-Worth (GSW). The associated Perceived Importance Rating Scale measured the importance placed on four sub domains (SC, PC, AB, PS). A discrepancy score between importance ratings and self-perception scores was calculated to indicate perceptual dissonance. Physical fitness measures included the MSFT, curl-ups, plank test, grip strength, 1RM chest, 1RM leg, standing broad jump, vertical jump and BMI. Partial correlations, controlling for gender, examined the relationship between subdomain scores and each fitness measure.

Results

In general, mean fitness measures, physical self-perception scores and importance ratings were below reported norms. Only one significant correlation between AB and plank (r =.58) was found. Many correlations were inverse, with no meaningful pattern to the data. On average 59% rated highly the importance of each subdomain, however the discrepancy with their physical self-perceptions was large. Females had higher dissonance in PS, PC and SC whereas males had least dissonance in SC but a slightly higher negative score in AB than females.

Discussion and conclusion

Adolescents with LMC do not base their physical self-perceptions on their actual fitness. Furthermore many had low self-perceptions in subdomains upon which they placed high importance. Such discrepancies have implications for overall self-worth and motivation to engage in physical activity and sport opportunities. Our findings point to the need for future research to identify causal pathways and mechanisms for enhancing physical self-concept in this population. Health promoting interventions might focus on behavioural drivers such as improving physical fitness and motor skills or on cognitive drivers that focus on strategies to build self-belief, resilience and compensating strategies, or both.

Keywords: low motor competence, physical fitness, self perceptions
Youth with Developmental Coordination Disorder and low motor competence have bone deficits similar to youth with neuromuscular and chronic diseases

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Background and aim

Recent evidence suggests a relationship between DCD and low motor competence (LMC) with poorer bone health outcomes and consequently an increased risk of secondary forms of osteoporosis. This compromised bone accrual has also been associated with other disease profiles. Hence the aim of this retrospective observational study was to compare peripheral long bone material and structural differences in youth with DCD/LMC with a clinical population being treated for conditions associated with risk of secondary osteoporosis.

Method

Upper (radius; ulna) and lower (tibia; fibula) limbs of children were scanned at 4% distal and 66% mid-shaft sites using peripheral Quantitative Computed Tomography (pQCT). Specific groups were (1) increased risk of secondary osteoporosis (neuromuscular disorders [cerebral palsy, Duchenne Muscular Dystrophy and Prolonged immobilisation]; chronic diseases; endocrine diseases; inborn errors of metabolism; iatrogenic conditions), (2) developmental coordination disorder or low motor competence and (3) non-affected controls. Outcome parameters were cortical density (CoD), cortical area (CoA), stress-strain index (SSI), total area (ToA), bone strength index (BSI), muscle density (MuD), muscle area (MuA), subcutaneous fat area, fat percentage, endocortical radius, pericortical radius, mid-cortical ring density and trabecular density. General linear models (GLM) with Bonferroni adjustment, controlling for age, sex and bone length examined disease group differences.

Results

The neuromuscular disorders and DCD/LMC groups were the most significantly different to non-affected controls. CoA was significantly different to the control group for all eight bone sites, with pericortical radius, SSI, ToA, and BSI significantly different to the control group for seven of the eight bone sites. Endocortical radius, MuA, and mid-cortical ring density were not significantly different to the control group for any bone sites. Whilst youth with neuromuscular disorders reported muscle and bone deficits for almost two-thirds of measured outcomes, youth with DCD/LMC had unique bone deficits of 7.5% compared to the clinical population group (Radius 66% ToA, Pericortical radius; Ulna 66% CoA, ToA, Pericortical radius). Youth with DCD/LMC also shared similar bone deficits to neuromuscular disorders group for 4.5% of bone and muscle parameters (Radius 66% SSI, Fat area, Fat%) and both neuromuscular disorders and chronic diseases group for 9.0% (Radius 4% BSI, Tibia 66% CoA, SSI, Fat area, Fat%).

Discussion and conclusion

Youth with DCD/LMC exhibit similar long bone material and structural deficits to youth with neuromuscular disorders and chronic diseases. As mechanical loading effects can be seen in regional bone analyses, targeted exercise interventions in youth with DCD/LMC should include components optimised for bone health.

Keywords: low motor competence, osteoporosis, neuromuscular disorders, DCD
Examining the changes across one year in physical activity and fitness in young children with and without motor coordination difficulties

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Background and aim

Children with Developmental Coordination Disorder (DCD) exhibit lower levels of physical activity (PA) and fitness compared to their typically developing (TD) peers. It is suggested that this deficit in PA and fitness will widen over time as skill demands increase, however the literature has largely focused on the mid- to late childhood period when PA and fitness deficits already exist. Therefore the purpose of this study is to examine changes in PA and fitness during early childhood in children with and without DCD.

Method

Participants ages 4- and 5-years at baseline (n = 532, TD = 319, DCD = 213) were recruited into the longitudinal cohort study, Coordination and Activity Tracking in Children (CATCH). Each year, participants were assessed for: motor coordination difficulties (Movement Assessment Battery for Children 2nd Edition); aerobic fitness (Bruce protocol); anaerobic fitness (30-second Wingate protocol); and PA through 7-days of wearing ActiGraph accelerometers. Children scoring on average at or below the 16th percentile were classified as at risk for DCD (DCDr).

Results

Results indicate that there were improvements in aerobic fitness for both TD and DCDr groups, but improvements were significantly greater for TD children ( MTD1 = 623.9, MDCD1 = 557.4, MTD2 = 736.0, MDCD2 = 653.9, Coef = -19.5, p = 0.02). While there were some improvements in anaerobic fitness, the increases were similar for TD and DCDr children. Overall, there were no significant changes in PA over time.

Discussion and conclusion

The results from this study suggest that the aerobic fitness of children with DCD is not increasing over time at a rate comparable to their TD peers. Given the negative consequences of poor fitness on overall physical and mental health, early intervention is critical. This study provides empirical evidence of the trajectory of DCD in early childhood and warrants further investigation regarding fitness changes over time in preschool aged children with DCD.

Keywords: physical activity, preschool, motor coordination, fitness
Impact of a 13-week targeted exercise intervention on Tibial bone mineral density and lower limb fitness measures in adolescents with DCD

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Background and aim

Adolescents with Developmental Coordination Disorder (DCD) or low motor competence (LMC) have significantly lower bone mineral density (BMD) compared to their coordinated peers. This may be due to a difficulty in efficiently performing weight bearing movement skills through-out childhood, such as jumping, which have been shown to improve BMD. This feasibility study examined the impact of a 13-week exercise intervention on tibial bone parameters and lower limb fitness in adolescents with DCD/LMC.

Method

Adolescents with DCD/LMC participated in a twice weekly 13-week exercise intervention, consisting of 90 minutes of cardiorespiratory, strength and resistance exercises. Bone parameters were measured at proximal (66%) and distal (4%) sites of the non-dominant tibia (T66 and T4) using peripheral Quantitative Computed Tomography. Fitness measures included the 1 Repetition Maximum (1RM) leg press, vertical jump and standing broad jump. Bone parameters and fitness assessments of the lower limb were measured pre and post intervention with pre-post differences explored using paired sample t-tests (or Wilcoxon signed-rank test). Generalised estimating equations (GEE) were used to evaluate pre-post intervention changes whilst controlling for gender, pubertal stage, age, number of sessions attended and body mass index.

Results

Twenty-eight adolescents, 17 boys and 11 girls, aged 12.6 years to 17.6 years (M=14.06, SD=1.28 years) with most adolescents in mid (n=14) or post (n=12) pubertal stages; (n=2 pre-pubertal). Significant increases post intervention were present for T66 mass (t(27)=2.75, p=.010, d=0.23), T66 cortical area (Z=2.45, p=.014, d=0.23), 1RM leg press (Z=2.78, p=.005, d=0.53), standing broad jump (t(27)=2.74, p=.011, d=0.15) and BMI (t(27)=2.30 p=.029, d=0.10). The GEE models for T66 mass and cortical area, found these changes were significantly associated with the number of sessions attended, in addition to vertical jump and standing broad jump measures.

Discussion and conclusion

Despite this short 13-week targeted exercise intervention and small effect sizes, significant improvements in some bone parameters in the lower leg were found. Considering that effects of bone adaptation may not be fully appreciated in this short time, these preliminary results suggest that adolescents with DCD/LMC can respond to targeted exercise focussed on loading the lower limbs and improve bone health outcomes. Further studies with a control group, larger sample and over a longer period of time are required to confirm positive changes to bone health, and determine whether optimal BMD scores similar to their coordinated peers can be achieved.

Keywords: low motor competence, bone health, mechanical loading, DCD
Neural Imaging tools to investigate cortical differences in children with DCD?

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The topic of planning has been of great interest in recent years and planning skills are thought to be impaired in a number of neurodevelopmental disorders, including ADHD, Autism and DCD. (van Swieten et al, 2010; Scheres et al, 2004; Hill, 2004; Smyth & Mason; 1997; Hughes, 1996). Current research evidence indicates that children with and without DCD are able to plan simple motor tasks, as performance on simple motor planning tasks in children with and without DCD is similar and they perform at age appropriate levels (Adams et al, 2017; Adams et al 2016; Noten et al, 2014; Smyth & Mason, 1997). When we move to more complex tasks, we see a decrease in performance efficiency, which purports to a potential deficit in motor planning (Fuelsher et al, 2016; Wilmot & Byrne, 2014).

Despite increased research activity within the area of DCD, the underlying mechanisms are very poorly understood and the focus of this workshop is to highlight some of the neural imaging tools that are currently being used to investigate motor planning in children with DCD.

By understanding simple and complex motor planning, it may provide some insight into how to tailor appropriate interventions to these children to lessen the negative later life consequences we are currently observing.

Neuroimaging modalities measure brain activity by detecting different physiological events triggered by neuronal activation. Electroencephalography (EEG) and magnetoencephalography (MEG) detect magnetic field changes induced by post-synaptic ionic current, while magnetic resonance imaging (MRI) and fNIRS assess hemodynamic changes related to energy usage and oxygen consumption. Different positives and negatives exist when comparing various neuroimaging techniques. While EEG has excellent temporal resolution, EEG signals are easily contaminated by head movements. fMRI also provides excellent spatial resolution but the accuracy of fMRI results is significantly affected by movement. fNIRS provides a balance between temporal and spatial resolution for monitoring local changes of oxygenation in the cerebral cortex. One benefit of fNIRs is its tolerance of movement artifacts, making ecologically valid studies possible.

In this workshop we will showcase fMRI, MRI, DWS and fNIRS work that is currently being carried out by an eclectic group of researchers from the USA and Australia and will have some hands on activities looking at real time motor planning tasks using fNIRS.

*Keywords: cortical differences, fNIRS, neural imaging*
Difficulties with motor skills in childhood have been linked to poor physical and psycho-social outcomes which often continue to impact through adolescence into adulthood. This highlights the importance of early intervention as a means to ameliorate such negative effects.

Animal Fun (Piek et al., 2010) is an intervention program developed specifically to meet the developmental needs of young children aged 3-6 years. The team of psychologists, physiotherapists and occupational therapists from Curtin University in Western Australia recognise the vital importance of play in the lives of young children and have designed Animal Fun to be a fun, interactive and non-competitive program which will appeal to young children of all abilities – but will be especially useful to those children who are having difficulty with their motor and/or social skills.

Results from a three-year randomised controlled trial which included over 500 children found the Animal Fun program to be effective at improving the overall motor proficiency of young children together with improved social and behavioural outcomes (Piek et al 2013, 2015). A further study by De Oliveira (2018) found that Animal Fun was effective in improving the specific movement skills of throwing and one leg balance. Both of these skills underpin other fundamental movement skills and lay the foundations for more complex actions needed for participation in sports and other lifestyle activities.

The aim of this interactive workshop is to provide delegates with an understanding of how the Animal Fun Program can be used to assist young children with developing and improving their motor and social skills. The workshop begins with an in-depth review of the Animal Fun research process and findings which will be delivered by Emeritus Professor Jan Piek via video. This presentation will be followed by a practical exploration of the Animal Fun program and resources by Program Director Sue McLaren. Sue will demonstrate and lead delegates through a selection of activities from within each of the 9 modules of the program with practical hints and creative ideas for implementation. Animal Fun is a useful tool for anyone working with young children whether that is in clinical practice, small groups or whole classes within the school setting.

*Keywords: Intervention Program, Evidenced based, Motor Skills, Social Skills*
Theoretical and experimental insights into the design of virtual rehabilitation solutions for DCD

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Background and aim

This conceptual paper examines how current theory/knowledge of motor and cognitive development, and participation can inform the use of new technologies (such as Virtual Reality – VR) in treating movement problems in children with neurodevelopmental disorders, especially DCD.

Method

The International Classification of Functioning, Disability and Health (ICF) will be used here to conceptualise the role of technology in treatment across body structures and function, activity/skill, and participation (WHO 2007; 2012).

Results

I first review the current experimental literature on DCD, focusing on the motor control and learning mechanisms that have been implicated in atypical motor development. Leading hypotheses about the neurocognitive basis of DCD are highlighted.

Discussion

This knowledge leads to a discussion of treatment strategies and techniques that may best facilitate learning in these children, i.e., targeted approaches to remediation that may involve provision of concurrent augmented feedback, dose-response modeling, knowledge of performance, and so on. I then review VR-based rehabilitation systems that have been developed for neurodevelopmental disorders that affect movement, focusing both on CP and recent applications for children with DCD. I describe the evolution of particular design innovations in virtual rehabilitation including recent advances in surface computing, commercial gaming systems and use of tangible interfaces, as well as other methods that target cognitive function more specifically. Benefits of these various treatments will be viewed through the lens of current theory and evaluated for efficacy at different ICF levels. Finally, I consider future directions in the use of technological innovation in rehabilitation and its impact on brain function, activity competence, and longer-term participation.
A randomized clinical trial protocol for children with Developmental Coordination Disorder: comparative effects between Wii-based and task-specific training

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Background and aim

To present main results of motor performance from a comparative protocol between Wii-based and task-specific training in children with Developmental Coordination Disorder (DCD).

Method

Six tasks were chosen from the Nintendo Wii shelf games and six others corresponding ones were implemented in the task-specific training (TST). The tasks from Wii were: Table Tennis, Frisbee, Archery, Bowling, Tightrope walk and Marble Balance (table tilt). For TST the corresponding tasks were: Table Tennis, Frisbee, Bow and Arrow, Bowling, Balance Beams, and Balance disc. Some adjustments were performed to afford a similar scoring system for both groups. Thirty-two children (eight girls) aged 8.28 ± 0.81 years were randomly assigned to the Wii group (16 children) or TST (16 children). Children filled the DSM-5 criteria for DCD, considering the cut-off below the 16th percentile in the MABC-2. Children performed 16 sessions (60 min each), twice a week, over eight weeks. The MABC-2 Total score and Manual dexterity, Aiming & Catching and Balance Component scores were used to evaluate the effects of the intervention on motor performance. Motor learning was assessed by games scores over the first 12 sessions. The motor learning was divided into three phases: Phase 1: from 1st to 4th session; Phase 2: from 5th to 8th session; and Phase 3: from 9th to 12th session.

Results

Wii group improved MABC-2 total score (pre-test: 53.00±15.92; post-test: 60.12±17.99; p < 0.01) similarly to the TST group (pre-test: 57.43±6.78; post-test: 66.75±10.40; p < 0.01), but no significant difference was found between groups (p = 0.47) in ANCOVA analyses. Considering MABC-2 component scores, only for balance significant difference pre and post-test was observed in Wii (p < 0.001) and TST (p < 0.001) groups, but also without significant difference between groups (p = 0.06). No significant changes were observed for others MABC-2 component scores (p > 0.05). Regarding the motor learning Delta analyses showed significant changes between groups in Frisbee (p = 0.02) and Bowling (p = 0.01) tasks. Superior improvements in Frisbee (Δ = 37.76) and Bowling (Δ = 29.81) tasks from Wii group were observed when compared to the TST group for both Frisbee (Δ = 1.56) and Bowling (Δ = 5.37) tasks.

Discussion and conclusion

Both protocols might be a feasible option to improve motor performance and motor learning in children with DCD. Additionally, this protocol enables a great management of this kind of intervention for clinicians’ practices.

Keywords: Motor Disorder, Motor Learning, Virtual Reality, Motor performance
Can we use Active Video Games to improve strength and conditioning in young children (7-12) with poor motor skills?

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Background and aim

The aim is to demonstrate how to apply strength and conditioning training principles to the development and implementation of Active Video Games (AVGs) in innovative ways to increase physical conditioning in children with and without motor deficits. Quite a number of studies have now shown that physical fitness can be improved using AVG in pediatric populations with low motor skills. In our last study involving high school girls aged 13-16 years, we showed that the graded Wii protocol may be capable of increasing crucial aspects of physical fitness. However, due to methodological challenges associated with the previous work, we decided to check how younger children would respond to this protocol.

Method

A clinical controlled trial was conducted among children in an elementary school (7-12; mean 9.4; n=48) in a low-income community of the Western Cape Province of South Africa with poor fitness and low motor skills (<20TH on the Shuttle Run and mean MABC-2 SS 6.6). Participants received a graded Wii protocol for 10 weeks by a trained staff in two weekly sessions of 30 minutes. The gaming environment of selected games were systematically made challenging by adding external weights and foam pads to the Wii balance boards. We also ensured that children performed the "intended movements" during gameplay, not only to use the remotes to control the avatar. Outcome measures included anaerobic fitness and motor coordination. We also recorded heart rate, Borg scale and Enjoyment during each episode of training.

Results

Graded AVG can improve motor coordination and anaerobic physical fitness (MABC-2 t=-6.08 and sprint t 29.46, p=0.01) in young children. Children did not perceive this training as very strenuous (mode value on the Borg scale was 13), although in most cases peak heart rate went up to 70% of their estimated maximum level. All children (really) enjoyed this form of AVG training and did not like the games less when we increased the task difficulty.

Discussion and conclusion

This intervention may be useful, easy to use playful tool to add to the armamentarium of clinicians working with children poor motor skills. However, it is important to build in overload and progression to keep the intensity high. Also, supervision during the training may be needed in this age group.
The impact of dual tasks and the role of motor and attentional abilities in children with DCD, ADHD and typically developing children

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Background and aim

Children with Developmental Coordination Disorder (DCD) are reported to be delayed in reaching an automatic stage in motor learning (APA, 2013; Wilson et al., 2017). If movements are less automatic more attentional resources have to be allocated to perform the task, which could cause cognitive overload and may present itself as an attention deficit. Interestingly, there is a large overlap (up to 50%) in symptoms between children with motor skill deficit and children with Attention Deficit Hyperactivity Disorder (ADHD) (Gillberg 2003 Fliers et al., 2010, Brossard-Racine et al., 2012). An important research paradigm to study attentional processes is the dual task paradigm, in which participants are asked to perform two tasks simultaneously. Cognitive-motor and motor dual tasks play important roles in the daily life of children. Our study aimed to analyse whether poor motor performance in a group of children with ADHD and DCD can be partly explained by attentional constraints.

Method

In this study 89 children were included, divided according to the inclusion criteria of DCD (n= 20), ADHD (n=29), and typically developing children (n=40). Motor performance was tested in a Wii Fit balance task under single or dual task demands. The dual task comprised of 1) playing the Wii Fit game, while also listening and counting as a cognitive-motor dual task and 2) playing the Wii Fit game while crossing one’s fingers as a dual motor task. Additionally, attentional abilities and reaction time to stimuli were measured with the divided attention task and distractibility task of the Test of Attentional Performance for Children – KITAP (Zimmerman, 2002) and balance skills by the Movement Assessment Battery of Children-2nd edition component balance (Henderson, 2007).

Results

The preliminary results indicated that the TD children performed significantly better than the ADHD and DCD group during the single and dual tasks on the Wii but there was no significant difference between the performances of the ADHD and DCD group. A relation was found between the attentional outcomes, the balance performance and the dual task outcomes. In all groups of children both the level of attention and level of balance performance explained part of the Wii-fit dual task outcome.

Discussion and conclusion

Since many tasks in daily life are dual tasks, it is important to measure dual tasking and to gain insight into the possible relation between attentional abilities and the ability of performing dual tasks in children with DCD and ADHD.
Functional connectivity in children with Developmental Coordination Disorder, with and without co-occurring Attention Deficit Hyperactivity Disorder: An exploratory study

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Background and aim

To compare resting-state functional connectivity between children with DCD, children with co-occurring DCD and ADHD, and typically-developing children. Developmental Coordination Disorder (DCD) is a common neurodevelopmental disorder, affecting 5-6% of school-age children. Children with DCD have difficulty learning motor skills (e.g., tying shoelaces, writing, riding a bicycle), which affects their participation in self-care, educational, and leisure activities. Half of children with DCD also have Attention Deficit Hyperactivity Disorder (ADHD), which further exacerbates their difficulties. The cause for DCD is unknown, but evidence suggests that children with DCD have atypical brain structure and function. Most of the neuroimaging studies in DCD have examined brain function during a specific task. While these studies provided valuable information about brain activation of children with DCD, limitations of these studies prevent a more definite conclusion regarding the neural correlates of DCD. An imaging method called resting-state Magnetic Reasoning Imaging (rsMRI) can overcome these limitations. rsMRI investigates which brain areas have parallel activation during rest. Areas that are active together during rest are often active together during specific types of tasks, so they are “functionally connected”. To-date, only two studies used rsMRI to investigate functional connectivity in DCD. Both studies used a method that require an a-priori assumption about the result to investigate functional connectivity within the motor system. However, since the current evidence regarding neural correlates of DCD are limited, and even more so regarding functional connectivity in this clinical population, an exploratory method that will investigate whole-brain functional connectivity is warranted.

Method

In this cross-sectional study, we used rsMRI to examine functional connectivity in 8-12-year old children (mean age=9y9m), diagnosed with DCD (n=26), DCD and ADHD (n=22) and typically developing children (n=27). We will use Independent Component Analysis (ICA), an exploratory data-driven approach, to investigate functional connectivity. We will use ANCOVA to compare functional connectivity between the groups, while controlling for the effect of age and sex.

Results

Data analysis is underway. We anticipate that compared to typically-developing children, children with DCD will demonstrate altered functional connectivity in the sensorimotor, cerebellar, fronto-parietal, and default-mode networks. Children with DCD and ADHD will demonstrate additional disruption in functional connectivity in dorsal-attention and fronto-parietal networks.

Discussion and conclusions

This first-of-its-kind study will increase understanding of the neurological differences that characterize DCD+/ADHD and may inform development of better rehabilitation treatments for these children.

Keywords: Developmental Coordination Disorder, Neuroimaging, Functional-connectivity
MRI correlates of developmental coordination disorder (DCD) in childhood

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Background and aim

To describe the brain magnetic resonance imaging (MRI) correlates of DCD in childhood. Despite the high prevalence of Developmental Coordination Disorder (DCD) in the general population, there is little consensus on its neural basis. Based on both MRI studies and theoretical models, grey and white matter differences have been postulated in a range of neural systems, including cerebellar, striato-cortical, fronto-parietal, and sensorimotor networks.

Method

We collected T1-weighted and Diffusion-weighted MRI data from 36 children aged 8-10 years who met DSM-5 criteria for DCD and 17 typically developing (TD) peers. We also conducted assessments of motor, intelligence, executive functions, and speech-language skills in all children. We examined (i) Morphological differences in brain structure (ii) Microstructural differences in white matter tractography reconstructions (iii) the association between MR metrics and motor performance. Vertex-wise Cortical thickness and surface area as well as cerebellar volume were extracted using FreeSurfer. Volumes of the basal ganglia nuclei were extracted using the FSL FIRST pipeline. White matter microstructure was analysed in the descending motor tracts, superior and middle cerebellar peduncles, and corpus callosum using MRtrix3.

Results

The DCD group performed poorer than the TD group on motor and executive function domains even when co-varying for IQ. Children with DCD also showed widespread speech impairments. There was no relationship between severity of motor deficit and additional impairments in children with DCD. MRI analysis revealed that distinct sensorimotor regions of the brain were associated with deficits in manual dexterity and in aiming/catching skills. We did not identify any relationships between motor skills and basal ganglia or cerebellar structures.

Discussion and conclusion

Our findings confirm the co-occurrence of executive function difficulties in a carefully characterised sample of children with DCD within a narrow age range. Distinct neural correlates of different motor functions were identified, suggesting separable patterns of brain alterations are related to different motor skills. This large MRI study suggests that sensorimotor anomalies are associated with DCD in school aged children. Replication in younger children is needed to examine whether these differences can be used as early neural predictors, or whether they develop alongside movement difficulties.

Keywords: diffusion-weighted tractography, voxel-wise analysis, MRI, dcd
Longitudinal Changes in Brain Volume and Structure in Very Preterm Children with Developmental Coordination Disorder

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Background and aim

Motor impairment in children born very preterm, including developmental coordination disorder, has been associated with neonatal brain pathology and structural brain alterations. To date, no studies have investigated brain growth and development from infancy to middle childhood in very preterm children with developmental coordination disorder. Aim of this study was to examine difference in brain volumes at term equivalent age, brain volumes and white matter microstructural organization at 7 years of age, and brain volume growth from term equivalent to 7 years in very preterm children with and without developmental coordination disorder.

Method

This longitudinal neuroimaging cohort study included 162 very preterm children from the Victorian Infant Brain Study (VIBeS) cohort who did not have cerebral palsy. Children were assessed at 7 years for developmental coordination disorder with the Movement Assessment Battery for Children 2. Assessors were blinded to perinatal/neonatal and magnetic resonance imaging data. Magnetic resonance imaging was performed between 2001 and 2003 at term equivalent and in 2008 to 2010 at 7 years. At term equivalent and 7 years, brain volumes were derived. White matter microstructure was examined at 7 years of age.

Results

At term equivalent, smaller brain volumes found in total brain tissue, cortical gray matter, cerebellum, caudate/accumbens, pallidum and thalamus in very preterm children with developmental coordination disorder compared with very preterm children without developmental coordination disorder; similar volumetric difference were present at 7 years. Longitudinal analyses revealed no evidence for better growth in very preterm children with developmental coordination disorder. At 7 years, very preterm children with developmental coordination disorder displayed lower fractional anisotropy and higher diffusivities in numerous major projections, association and commissural white matter tracts associated with motor functions.

Discussion and conclusion

Infants born very preterm with developmental coordination disorder at 7 years of age display smaller brain volumes that persist throughout early childhood, and changes consistent with poorer white matter microstructure organization. Future studies should examine whether early intervention reduces the prevalence of motor impairment in very preterm populations and promotes development of the cerebellar, basal ganglia and white matter tracts in very preterm children at risk for developmental coordination disorder. Alterations in brain volumes in very preterm children with developmental coordination disorder at 7 years are present at term equivalent age and persist to 7 years of age. At 7 years, very preterm children with developmental coordination disorder evidence disrupted white matter development.

Keywords: brain volumes, brain structure, longitudinal brain growth, very preterm children
Learning and retention of a temporal sequence in children with Developmental Coordination Disorder depend on the modality (auditory vs visual) of stimulations

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Background and aim

To date, the question of whether motor learning is impaired in DCD remains open. This study investigates (1) a possible deficit in synchronization, learning and retention of a temporal sequence in DCD children (2) as a function of the sensory modality of the sequence and (3) the cortical correlates.

Background. Compared to visual stimulations, auditory stimulations induce spontaneous sensorimotor synchronization in healthy people, hence facilitating motor control and learning, in association with activations of frontal and parietal cortical regions. We hypothesize that motor synchronization and learning would benefit from auditory cues, but less in DCD children who present atypical fronto-parietal structures.

Method

16 typically-developing (TD) and 11 DCD children during synchronization of auditory and visual regular temporal sequences, learning and retention of auditory and visual non-regular temporal sequences. Accuracy and stability of the produced sequence were tested. Correlations with the cortical thickness of 11 regions of interest (whole brain) acquired with Magnetic Resonance Imaging were also tested.

Results

Compared with TD children, DCD children present (1) less stable synchronization with regular rhythmic stimuli whatever the sensory modality, (2) less stabilization during learning and more increase of the number of errors during retention of the auditory non-regular temporal sequence. For all children, (3) the stability of synchronization with auditory sequence is correlated with the cortical thickness of (a) sensorimotor and (b) occipital cortices.

Discussion and conclusion

Despite a general deficit in synchronization of a regular temporal sequence, DCD children present specific deficit in learning and retention of auditory (not visual) non-regular temporal sequence. For all children, higher stability of synchronization is linked with lower thickness of sensorimotor and visual cortical regions. In accordance with our hypotheses, learning of non-regular temporal sequences was impaired in DCD children with the auditory modality: they failed to improve synchronization despite repeated exposition to the auditory sequence, especially when their cortical thickness of sensorimotor and occipital regions is high. This suggest a deficit or immaturity of audio-motor coupling in DCD.

Keywords: synchronization, cortical thickness, procedural learning
Effect of rehabilitation on motor outcomes and brain functional connectivity of children with developmental coordination disorder

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Background and aim

We aim to examine the effect of CO-OP intervention on motor outcomes as well as functional connectivity in children with DCD. Cognitive Orientation to Occupational Performance (CO-OP) is a client-centred rehabilitation approach primarily designed for children with Developmental Coordination Disorder (DCD) to improve child-chosen functional motor goals. It focuses on use of cognitive-based, problem-solving strategies to influence motor skill acquisition. CO-OP is current best-practice for children with DCD to improve functional motor goals, but the neural basis of this approach is unknown.

Method

Twenty-six children with DCD (8-12 years) received CO-OP intervention once a week for 10 weeks. Children were assessed during pre- and post-intervention sessions for their performance and satisfaction of their chosen motor goals using Canadian Occupational Performance Measure. Performance Quality Rating Scale was used to objectively measure change in performance and the Bruininks-Oseretsky Test of Motor Proficiency-2 was used to assess motor skills. Functional connectivity was measured using MRI at rest (resting-state MRI).

Results

Results showed a significant improvement in children’s performance [pre-test mean(SD): 2.88(1.36); post: 6.61(1.29), p<.001], satisfaction [pre: 2.33(1.26); post: 7.19(1.5), p<.001], and performance quality [pre: 3.27(1.55); post: 6.7(1.26), p<.001] in their chosen functional goals. As expected, BOT-2 showed no significant improvement in overall motor skills after CO-OP intervention [pre: 38.92(5.21); post: 40.5(6.53), p=0.08]. Resting-state data analysis is still ongoing. Independent component analysis (ICA) and graph theory will be used for resting-state MRI data analysis. ICA is a data-driven approach to explore the correlation between brain regions activation forming a resting-state network. Graph methods will also be used as a complementary approach to ICA in order to provide information about the actual connections between regions. This approach views each resting-state network as a collection of nodes connected by edges where nodes represent brain regions and edges are the functional connections between them.

Discussion and conclusion

CO-OP intervention is a useful and promising approach in helping children with DCD to achieve functional motor goals. Further analysis of neuroimaging data will help us understand the underlying neural mechanism of these improvements.

This is the first study of its kind to integrate neuroimaging and rehabilitation for children with DCD. This study will contribute to our understanding of how current best-practice rehabilitation improves motor outcomes for children with DCD and can lead on changing the policy to making CO-OP the standard of care for these children.

Keywords: Cognitive Orientation to Occupational Performance, Brain changes, Functional Connectivity, DCD
Cerebellar Differences with Rehabilitation in Children with Developmental Coordination Disorder

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Background and aim

To investigate whether a rehabilitation intervention, Cognitive Orientation to Occupational Performance (CO-OP), induces structural changes in the cerebellum of children with Developmental Coordination Disorder (DCD). CO-OP is effective in helping children with DCD to achieve functional motor goals, but the neural mechanism underlying this intervention is unknown. Given the hypothesized role of the cerebellum in DCD, we sought to determine if CO-OP was associated with changes in cerebellar structure and if these changes were associated with improved motor outcomes.

Method

Sixty children with DCD (8-12 years) were randomized into the treatment or waitlist group; the treatment group began CO-OP after the first MRI scan and waitlist group waited until after the second scan. Each child participated in weekly, 1-hour CO-OP sessions for 10 weeks and then had the final MRI scan. Voxel Based Morphometry (VBM) was used to explore differences in cerebellar grey matter volume between the treatment and waitlist groups. Linear correlation was used to explore preliminary data for the relationship between grey matter volume and clinical measures of motor skills.

Results

To date, 43 participants have completed the study. Using quality scans suitable for VBM analyses (n=18; treatment (8); waitlist group (10)), preliminary findings indicate that following CO-OP, children in the treatment group had increased grey matter volume in motor regions of the cerebellum (Lobule IX & Lobule VI, both p<0.001) compared to the waitlist group. Children in the treatment group also had increased grey matter volume in regions associated with cognitive skills (Crus I & Crus II, both p<0.001).

Discussion and conclusion

Our previous work showed that children with DCD have larger volumes in Crus I and Crus II and smaller volumes in Lobules VI and IX compared to typically-developing children. Following CO-OP, children with DCD begin to show increased grey matter volume in regions associated with sensorimotor functioning, indicating that CO-OP is associated with structural changes in the cerebellum. Increased grey matter volumes in cognitive regions indicates that we are accessing the strength of these children and using it to improve functional motor skills. In the upcoming months, the structural changes will be correlated examined with respect to motor outcomes to determine if they are associated with improvements in functional motor skills. As a novel study investigating cerebellar changes associated with CO-OP, these findings offer clinicians and researchers greater understanding of neurological underpinnings of motor difficulties in children with DCD and illustrate CO-OP’s effectiveness.

Keywords: Cognitive Orientation to daily Occupational Performance (CO-OP), Cerebellum, Neuroimaging, Motor Learning
Using implementation science to adapt Partnering for Change to different health- and education contexts: An example of tiered school-based service delivery model in Quebec, Canada

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Background and aim

Service delivery based on tiered approaches may optimize services for school-age children with disabilities, including those with Developmental Coordination Disorder (DCD). Partnering for Change (P4C) is an example of an evidence-informed tiered model that has been evaluated. Implementation science can guide studies of its applicability in other health- and educational contexts. Aim. To describe the active ingredients of P4C and its has been adapted to fit the characteristics and needs of a new context.

Method

The 16 core-attributes of P4C, identified by a Delphi-process with P4C team members, were compared with the literature on best practice in DCD and pediatric rehabilitation. Within each attribute, components were identified for which there was evidence. In parallel, we worked with stakeholders in 7 schoolboards and surveyed school staff in 3 schools, and identified themes relating to stakeholders’ perceptions of their current and ideal roles in a tiered model. Findings were used to refine the P4C model and prepare its implementation.

Results

P4C attributes related to building capacity, collaboration, coaching and working in context, and were all supported by the literature as active ingredients. However, more information was needed to guide implementation (e.g. spending time in the school relate to relationship- and capacity-building with teachers; however, evidence is lacking regarding the time or frequency required). All of the core P4C attributes are thus evidence-informed but need to be adapted to local contexts. In Quebec, Canada, school staff identified a need for receiving more training and support to manage all children with special needs, specifically with regards to classroom and behaviors management. They also wished to improved teamwork, communication, and access to resources, and needed clarification of roles and expectations within their Response-to-intervention (RTI)/tiered model. Opportunities were seen to involve rehabilitation professionals in the implementation of RTI/tiered model. Currently, 3 OTs are implementing an adapted version of P4C in 2 different school boards.

Discussion and Conclusion

P4C core attributes appear to be applicable across contexts; however, P4C might need to be delivered differently. The new RTI/tiered model is currently implemented for all children with special needs, including DCD, and might eventually be used by various non-teaching professionals from different disciplines. Services included universal design for learning, differentiation and accommodation, but a greater emphasis in put on relationship building with parents and community or rehabilitation services. These are significant results since its demonstrated how the attributes of P4C can be applied across contexts.

Keywords: school, organization of services, health services research
Use and effects of a web platform to support parents of children with developmental coordination disorder (DCD)

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Background and aim

1-Explore the feasibility of using a web platform to support parents of children with DCD. 2-Describe its impact on parent’s knowledge and skills. Background: Best practices in rehabilitation for children with DCD suggest offering support to parents to maximise children’s every day functioning. Web platforms are used to assist parents in other paediatric rehabilitation contexts, yet their usability and efficacy have to be assessed in the DCD population.

Method

A randomized controlled feasibility trial design was conducted. Parents of children aged 5 to 12 years-old with suspected or diagnosed DCD were recruited. The intervention group (n=15) had 3-month access to a web platform with informational resources, forum, and virtual interaction with an occupational therapist via a private forum or videoconferencing. The control group (n=13) had access to the informational resources only. Feasibility was documented via recruitment rate and parents use of the web platform. Data collected included web system statistics, pre-post questionnaires, and qualitative interviews.

Results

Seven participants per month were recruited. Parents used the platform mainly to access the resources or to read information on the forum. Virtual interactions with therapist were minimal. To enhance participation, parents suggested scheduling an initial meeting with the therapist to ensure a complete understanding of all platform features (including access to virtual interaction). No group (p=0.190) or time (p=0.859) effects were found for parental knowledge and skills. However, access to web information increased parental understanding of the impact of motor difficulties for families awaiting a diagnosis (p=0.036) or who had never received services (p=0.024). Discussion: Recruitment was challenging and use of the web platform was lower than expected. However, results are promising, and parents formulated various recommendations, especially to improve the use of web platform and its benefits for parents of children with suspected DCD who have yet no access to services.

Discussion and conclusion

Using web platforms to support parents is feasible and promising. To better support parents, online information should be offered as soon as families identify developmental concerns. Future interventions should include greater synchronous support to families, including an initial session about the platform and regular, pre-schedule meetings. Further investigations are needed to compare the added benefits of virtual interventions to informational online resources.
Keywords: Rehabilitation, Parental support, Web platform
Appropriateness of different pedagogical approaches to road safety education for children with Developmental Coordination Disorder (DCD)

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Background and aim

This study aimed to test the road crossing accuracy of children with and without DCD in augmented reality tasks that varied the viewpoint to simulate the teaching methods currently used in road safety educational programmes.

In 2016, 29% of pedestrians killed or seriously injured on the roads in Great Britain were under 15 years of age. Previous research suggests that children with DCD may be more vulnerable at the roadside compared to their typically developing (TD) peers. Current methods used to teach road safety are typically knowledge-based and do not necessarily improve behaviour in real traffic situations. Augmented reality road crossing tasks may be a viable alternative.

Method

Twenty-one children with DCD and twenty-one age and gender matched TD peers were required to locate the safest road crossing sites in two augmented reality conditions: allocentric (aerial viewpoint) and egocentric (first-person viewpoint). All children completed both conditions and were required to navigate either themselves or an avatar across the road using the safest crossing route. The primary outcome was accuracy defined as the number of trials, out of 10, the child successfully identified and used the safest crossing route.

Results

TD children performed significantly better on the egocentric task compared to the allocentric task, but this difference was not observed in the children with DCD, who performed equally poorly in both conditions. The reasons for this lack of difference between conditions for the DCD group are not immediately apparent, but findings from the road crossing questionnaire suggest that the results cannot be explained by prior independent road crossing experience or frequency of independent road crossing practice, which were not significantly different between TD and DCD groups.

Discussion and conclusion

Given the overall vulnerability of children at the roadside, and the widespread availability of augmented reality technology, developing new and innovative methods of teaching road safety should continue to be explored. The results of the present study highlight the value of a first-person, realistic augmented environments (egocentric) over a less immersive, aerial viewpoint task for road safety accuracy for typically developing children. However, this may not be sufficient for children with DCD, who may benefit from multimodal methods.

*Keywords: augmented reality, DCD, Road safety education*
Investigating the Effects of Interpersonal Feedback on Relation-Inferred Self-Efficacy, Self-efficacy and Exercise Performance in Young Children with Developmental Coordination Disorder

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Background and aim

Children with Developmental Coordination Disorder (DCD) struggle with performing common everyday tasks (e.g., tying shoelaces, catching a ball) due to impairments in motor coordination. Children with DCD also have lower levels of physical fitness when compared to typically developing (TD) children. Children with DCD report lower perceptions of ability (i.e., self-efficacy) for performing tasks requiring motor coordination, which in turn, has been shown to mediate the relationship between DCD and performance on physical fitness tests. Research based on Self-Efficacy Theory (Bandura, 1997) implies that children’s perceptions of what others believe about their capabilities (relation-inferred self-efficacy [RISE]) positively correlates with their self-efficacy towards motor activities. The purpose of this study is to investigate whether interpersonal feedback (from an influential source) increases children’s RISE and self-efficacy towards fitness performance, and whether this type of feedback also increases performance on aerobic and anaerobic fitness tests.

Method

Based on sample size calculations, 100 participants (50 DCD, 50 TD, 6-8 years of age) will be recruited from a larger cohort study, the Coordination and Activity Tracking in CHildren (CATCH) study. At their 3rd annual visit, all children will complete measures of physical fitness (standing long jump, progressive treadmill test, Wingate anaerobic test). Prior to these measures, they will fill out a questionnaire assessing their self-efficacy and motivation for performing these fitness assessments. Two weeks later they will come back to the lab to complete the same questionnaire and fitness tests. However, prior to completing these measures, participants in the experimental condition (25 DCD, 25 TD) will receive self-efficacy enhancing feedback (“I believe in you! I know you will do a lot better than last time”) from an athletic trainer (i.e., research confederate).

Results:

Hypothesis: Children with DCD will report lower perceptions of self-efficacy and motivation towards the fitness tasks compared to TD children, which in turn, will mediate the relationship between DCD and fitness performance. Self-efficacy enhancing feedback will increase perceptions of RISE, self-efficacy, and motivation, which in turn, will lead to improved performance on the fitness tests compared to the first visit, and this effect will be stronger in children with DCD.

Discussion and conclusion

Children with DCD report low perceptions of motor skill ability even at a very young age. Findings from this study will provide evidence for ways to manipulate perceptions towards physical tasks as a means to build their self-efficacy for performing physical tasks in general.

Keywords: Self-efficacy, Developmental Coordination Disorder in childhood, Exercise performance, Relation-inferred self-efficacy
Fibre Specific White Matter Organisation in Developmental Coordination Disorder: Evidence from Fixel-Based Analysis

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Background and aim

Diffusion tensor imaging (DTI) has provided valuable evidence that white matter organization of sensorimotor tracts, typically indicated by reduced fractional anisotropy (FA), may be reduced in Developmental Coordination Disorder (DCD). However, findings have been inconsistent. This is unsurprising given that voxel-averaged DTI metrics are both non-specific and difficult to interpret, particularly in crossing-fibre areas that constitute most of the brain’s white matter. To this end, the aim of the present study was to investigate white matter organisation in DCD using Fixel Based Analysis (FBA), a recently developed whole-brain analysis framework that allows for comprehensive analysis of white matter quantitative measures in the presence of complex fibre populations.

Method

High angular resolution diffusion imaging (HARDI) data was obtained from 7 adults who met the DSM-V criteria for DCD (4 females, mean age = 23.29 years) and 12 controls (3 females, mean age = 26.16 years). We assessed differences in fibre microscopic density and macroscopic morphological measures between adults with and without DCD using both whole brain and tract-based FBA.

Results

Connectivity-based fixel enhancement statistics (using permutation testing) demonstrated that adults with DCD showed up to 20% reduction in fibre cross-section in key sensorimotor white matter tracts, including the superior longitudinal fasciculus (SLF), the corticospinal tract (CST) and the rostral body/anterior midbody (CC3/CC4) of the corpus callosum. No systematic differences were observed outside these motor tracts.

Discussion and conclusion

These findings provide important pilot work towards clarifying disparate evidence from earlier DTI studies and support the view that differential white matter organisation in DCD, particularly with respect to higher order sensorimotor processing and interhemispheric communication, may contribute to the symptom profile of this disorder.

Keywords: Fixel, Diffusion, White matter, MRI
The role of the primary motor cortex in motor imagery in individuals with and without developmental coordination disorder: a theta burst stimulation study

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Background and aim

Motor imagery (MI), the ability to mentally simulate a given movement, is thought to play an important role in producing forward models of action that subserve efficient motor control, planning and development. Accordingly, evidence suggests that the motor impairments characteristic of developmental coordination disorder (DCD) may emerge, in part, due to deficits in MI functioning. With this in mind, it has been proposed that MI based therapies may be a viable method for treating individuals with motor difficulties, including those with DCD. However, the efficacy of such interventions remains varied due to a limited understanding of the underpinning neural constructs of MI, particularly the role of the primary motor cortex (PMC). This study is examining the function of the PMC during MI in young adults with and without DCD. This will be achieved by using continuous theta burst stimulation (cTBS), a form of repetitive transcranial magnetic stimulation, that can temporarily induce long-term depression-like (i.e. inhibitory) effects in those cortices stimulated.

Method

Young adults with and without DCD aged 18-30 years old are currently being recruited to attend three sessions. During two separate sessions, participants complete the hand rotation task (HRT), a well validated measure of MI, after receiving cTBS to the PMC and the supplementary motor area (SMA). This assesses whether reduction in activity within the PMC and SMA influences MI ability when completing this task. The SMA is also being examined in this study to see if the observed effects on MI are due to the PMC itself, or spill over activity arising from the SMA that is also thought to be important for movement. During a third session, participants complete the HRT following sham cTBS to either the PMC or SMA. Sham cTBS involves the same procedures as active conditions, however, unbeknownst to the participant and experimenter administering the TMS, an active pulse is not delivered. Thus, the 'sham' forms a control condition.

Results

Data is currently being collected and results of this study will be discussed.

Discussion and conclusion

As data is still being collected, we anticipate that applying cTBS to the PMC in young adults with typical motor ability will reduce their MI efficiency relative to the sham condition. However, applying cTBS to the PMC is not predicted to affect MI efficiency among individuals with DCD. The implications of these results will be discussed.

Keywords: Hand Rotation Task, Continuous Theta Burst Stimulation, Primary Motor Cortex, Motor Imagery
White matter organization in developmental coordination disorder: A pilot study exploring the added value of constrained spherical deconvolution

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Background and aim

Previous studies of white matter organization in sensorimotor tracts in developmental coordination disorder (DCD) have adopted diffusion tensor imaging (DTI), a method unable to reconcile pathways with ‘crossing fibres’. In response to limitations of the commonly adopted DTI approach, the present study employed a framework that can reconcile the ‘crossing fibre’ problem (i.e., constrained spherical deconvolution- CSD) to characterize white matter tissue organization of sensorimotor tracts in young adults with DCD.

Method

Participants were 19 healthy adults aged 18-46: 7 met diagnostic criteria for DCD (4 females) and 12 were controls (3 females). All underwent high angular diffusion MRI. After preprocessing, tractography was conducted to delineate the left and right corticospinal tracts (CST) and superior longitudinal fasciculus (SLF) based on CSD and DTI analyses respectively.

Results

Based on the CSD model, individuals with DCD demonstrated significantly decreased mean apparent fibre density (AFD) in the left SLF relative to controls (with large effect size, Cohen’s d= 1.32) and a trend for decreased tract volume of the right SLF (with medium-large effect size, Cohen’s d = .73). No differences in SLF microstructure were found between groups using DTI, nor were differences in CST microstructure observed across groups regardless of hemisphere or diffusion model.

Discussion and conclusion

Our data are consistent with the view that motor impairment characteristic of DCD may be subserved by white matter abnormalities in sensorimotor tracts, specifically the left and right SLF. Given the increased anatomical accuracy afforded by CSD relative to DTI, higher order diffusion modelling of white matter organization is well-placed to clarify earlier inconsistencies in reports speaking to white matter organization in DCD, and its contribution to poor motor skill in DCD.

Keywords: white matter, DTI, diffusion MRI, CSD
Cortical thickness of fronto-parietal networks in children with DCD

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Background and aim

Our previous study revealed that children with Developmental Coordination Disorder (DCD) demonstrated poorer motor planning on tasks with increased motor demands (Bhoyroo, Hands, Wilmut, Hyde & Wigley, 2018). Further, neuroimaging studies (Langevin, Macmaster & Dewey, 2014) have demonstrated morphological differences in frontal regions e.g., precentral gyrus. The postcentral gyrus, precentral gyrus, superior frontal gyrus and the superior parietal lobule have been implicated in motor planning (Hanakawa, Dimyan & Hallet, 2008). To-date, no study has investigated the relationship between motor planning and cortical thickness in children with DCD.

Method

High resolution, whole-brain anatomical magnetic resonance images (voxel size = 1mm x 1mm x 1mm) were acquired in 9 boys with DCD and 11 age and gender matched controls (mean age = 9.93y, range 7-12y). Children were classified using the Neuromuscular Developmental Index of the McCarron Assessment of Neuromuscular Development [DCD &8804; 85 (15th percentile); typically developing &8805; 90]. Motor planning was assessed using a grip selection (octagon) task. Participants were instructed to grasp an octagon and rotate it to assigned colour sequences. End State Comfort (ESC) was calculated, with higher scores denoting higher planning ability. Freesurfer v5.3 (https://surfer.nmr.mgh.harvard.edu/) was used to obtain cortical thickness from the following regions of interest (ROIs): bilateral inferior parietal lobule, precentral gyri, postcentral gyri, superior frontal gyri, superior parietal lobule and supramarginal gyri. Univariate analyses using Generalised Estimating Equation (GEE) model were conducted with ESC as a dependent variable, ROI as a covariate and controlling for hemisphere and group, with a two-way interaction explored for group x ROI.

Results

Significant group differences were observed for the octagon task (p < 0.05). In addition, across ROI GEE models, cortical thicknesses of the inferior parietal lobule (p = 0.023), postcentral gyri (p = 0.001), precentral gyri (p = 0.036), superior frontal lobule (p = 0.008), superior parietal lobule (p = 0.005) and supramarginal gyri (p < 0.001) were associated with ESC. An interaction effect was observed only for the precentral gyrus (p = 0.005). There were no differences between hemispheres for any ROIs.

Discussion and conclusion

Findings indicate that differences in the inferior parietal lobule, postcentral gyri, precentral gyri, superior frontal gyri, supramarginal gyri and superior parietal gyri were associated with motor planning ability. For children with DCD, thinner precentral gyri were associated with poor motor planning ability. Decreased motor planning efficiency in children with DCD may be subserved by a reduced cortical thickness of the precentral gyrus.

Keywords: ESC, motor planning, frontal, parietal
Does the relationship between self-perceptions and identity health differ between adolescents with low and high motor competence?

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Background and aim
To examine the relationship between identity health and self-perceptions in male and female adolescents with high and low motor competence. Adolescence is a particularly important time for development of identity and self-perceptions as many environmental and personal factors impact this process. One factor warranting consideration is level of motor competence.

Method
Adolescents (N = 160, 64.4% males, Mage = 14.45yrs) completed the Adolescent Motor Competence Questionnaire (AMCQ), Assessment of Identity Development in Adolescence (AIDA) and Harter’s Self-Perception Profile for Adolescents (SPPA). The sample was grouped into high (HMC) and low (LMC) motor competence based on their AMCQ scores. Pearson’s product-moment correlations between the AIDA and SPPA subscales were derived for each competence group, gender-based sub-groups and gender only.

Results
Adolescents with LMC had higher AIDA scores (less-healthier identity) than those with HMC, which meant they had a lower sense of self and social connectedness. For the LMC group, significant correlations were found between AIDA scores and self-perceptions of scholastic competence (r = -.58), physical appearance (r = -.59), close friendships (r = -.48) and global self-worth (GSW; r = -.78), but not for social or athletic competence, or romantic appearance. For the HMC group, significant correlations were found between AIDA scores and all self-perception domains. When grouped for gender and motor competence, the males with HMC had the healthiest identity scores and all self-perception subdomains correlated significantly except for job competence. For the males with LMC, only scholastic competence (r = .57), behavioural conduct (r = -.65) and GSW (r = -.61) were significantly related. The females with LMC had the least healthy identity. Their AIDA scores correlated with self-perceptions of GSW (r = -.82), physical appearance (r = -.65), close friendships (r = -.58), scholastic competence (r = -.55), behavioural conduct (r = -.48), and social competence (r = -.43).

Discussion and conclusions
Positive self-perceptions across a range of domains are associated with a healthier identity, these differ according to level of motor competence and gender. For those with LMC, only self-perception subdomains unrelated to physical activity and sport were associated with a healthy identity. For the males, these related mainly to school-based aspects whereas for females perceptions of self-worth and close friends were most significant. Consideration of these findings should guide interventions designed to minimise the negative impact of LMC in adolescents, as their identity is most impacted by aspects of their life other than sports participation.

*Keywords: motor competence, adolescence, Identity*
Health-related quality of life of children with developmental coordination disorder

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Background and aim
Developmental coordination disorder (DCD) affects 4-6% of school-aged children worldwide. They are characterized by problems with motor planning and coordination resulting in inferior motor performance compared to their typically developing peers (TD). Their poor motor skills adversely affect their daily functions and activity participation. However, little is known about the influence of motor ability on the quality of life of children with DCD. Study compared the health-related quality of life (HRQOL) between children with DCD and TD children.

Method
A cross-sectional exploratory study was carried out. Both children with and without DCD aged between 6 to 9 years old were recruited from the community in Hong Kong. Pediatric Quality of Life Inventory Version 4.0 Short Form – Generic Core Scales (PedsQL 4.0 SF15) Child Self-report and Parent Proxy-report for age 5-7 years (young child) and age 8-12 years (child) were administered in the participants and their parents, respectively, according to the child's age. There were totally 15 questions in both questionnaires under 4 different dimensions – physical, emotional, social and school functioning. Each item was scored either on a 5-point Likert scale or 3-point Likert scales. The scores were then reversely scored and linearly transformed to a 0-100 scale. The mean scores (sum of item scores over the number of items answered) were computed to derive the Physical Health Summary Score, Psychosocial Health Summary Score, and Total Score in children and their parents. Higher scores indicate better HRQOL.

Results
52 children with DCD (mean age ± standard deviation = 7.08 ± 1.27 years) and 52 children with TD (mean age ± standard deviation = 6.77 ± 1.14 years) participated in the study with their parents. The Child Physical Score (p < 0.001), Child Total Score (p = 0.004), Parent Psychosocial Score (p < 0.001) and Parent Total Score (p = 0.005) were significantly lower in children with DCD than those with TD. No between-group differences were detected in Child Psychological and Parent Physical Scores.

Discussion and conclusion
Children with DCD demonstrated an overall lower HRQOL, particularly in the physical aspect; while their parents perceived an overall lower HRQOL in their children, particularly in the psychological aspect. The lower health-related quality of life in children with DCD should be addressed and requires attention. Different ways to enhance their HRQOL (e.g., improving motor skills and performance through physical training) should be incorporated into the rehabilitation programs for these children.

Keywords: dyspraxia, quality of life, rehabilitation
Comparisons of Self-report Motor Competence in Adolescents aged 12-18 yrs in Regional Victoria (rVIC) and Western Australia (WA) using the Adolescent Motor Competence Questionnaire (AMCQ)

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Background and aim
Poor motor skill development is an increasing issue for adolescents in our local communities and current research is exploring actual and self-reported motor competence to better understand the issues (Timler et al 2017; Plumb et al, unpublished). The aim of current study was to explore and compare self-report motor competence in adolescents in WA and rVIC, using the AMCQ (Timler et al, 2016), a questionnaire for adolescents to self-report high (HMC) and low (LMC) motor competence (<83).

Method
A total of 357 adolescents, 200 (56%) females, 157 (44%) males (Mage = 15.02 years, SD = 1.47), mean AMCQ of 88.75 (SD = 9.879) participated. With AMCQ score as the dependent variable, a GLM was completed for each item controlling for response category (positive or negative) and state (WA and rVIC).

Results
Adolescents reported higher HMC (AMCQ = >83) = 248 (109 WA, 139 rVIC) compared to LMC (<83) = 107 (63 WA, 44 rVIC). AMCQ across states was similar: WA [174, 62 (35.6%) females, 112 (64.4%) males, Mage = 14.35 years (SD = 0.825)] and rVIC [183, 138 (75.4%) females, 45 (24.6%) males, Mage = 15.65 years (SD = 1.657)]. AMCQ was significantly higher in males (WA=88.36; rVIC=89.73) compared to females (WA=80.51; rVIC=87.25) in both states. rVIC (87.86, SD = 7.46) had significantly higher AMCQ scores compared to WA (85.58 (SD = 11.87) df, t (353 = 21.88 p = 0.029). GLM showed significant differences (p<.05) in AMCQ scores for all items, negative responders with lower AMCQ scores than positive responders. rVIC scored significantly higher than WA in 11/26 items.

Chi square of AMCQ score and state was significant (p<0.05) for eight items (Gross motor, Fine motor and Participation). For seven of the eight items, rVIC responded with higher percentage of positive responses. Only the item ‘kicking a ball’ had a higher percentage of positive responses among WA adolescents.

Discussion and conclusion
Overall, males reported higher motor competence compared to females, which may due to differences in physical activity opportunities between males and females. Clear differences between response categories (positive or negative) were seen, suggesting adolescence is an appropriate age to use self-report. Across states, rVIC rate their motor competence higher than WA, which may relate to all around opportunities to be physically active.

Keywords: AMCQ, Motor Competence
Perceptions of coordinated movement

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Background and aim

Humans are highly social creatures and rely heavily on the ability to perceive what others are doing. Research has identified that movement properties are important for evaluating the social competencies of others. For example, smoothness of movement is often perceived to signal an attractive, trustworthy or competent person. Conversely, individuals with poor movement coordination skills, such as those with Developmental Coordination Disorder (DCD), have been associated with peer relationship difficulties and lower sociometric preference scores. The aim of this proposed study, therefore, was to explore the perceptions of social competence that typically developing individuals have of individuals with and without DCD.

Method

Two groups of participants took part in this research; group 1 comprised four ‘models’ (two adult males with DCD and two male controls) and group 2 was an ‘audience’ of 42 (27 female) typically developing adults (mean age 37 years). 3D motion capture tracked the movement of the four models in a variety of everyday scenarios. Kinematic footage of the model’s movements was presented as a point-light-display to the audience who used The Rating Scale of Social Competence to detail their perceptions of the model’s social competencies.

Results

Initial analysis (data collection is ongoing) shows that the models with DCD were rated significantly lower on The Rating Scale of Social Competence compared to the controls (t(39) = -7.99, p < .001, d = 1.27).

Discussion and conclusion

These findings highlight the importance of motor ability in the perception of social competence. If individuals with DCD are being excluded from social or group activities, it may be that negative judgements applied to individuals with movement coordination difficulties mediate the higher prevalence of loneliness, isolation and mental disorders reported for this population. This research is highly significant as it increases our understanding of how humans incorporate non-verbal information to evaluate the social competencies of others. It will inform theoretical advances, expanding our understanding of the range of competence-based stereotyping to new groups and provide a framework for understanding the social inequalities that people with DCD encounter. The findings from this work highlight the importance of educating the typically developing population about perceptions of coordinated movement in addition to improving the motor skills of individuals with DCD.

Keywords: social competence, perception, coordinated movement
An ecological model of childhood participation – Implications for understanding DCD

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Background and aim
This paper outlines a new conceptual model for understanding participation in relation to childhood disorders like DCD (see also Imms et al., 2017). A starting assumption is that ‘participation’ in meaningful activity is critical to healthy development, building skills, interests, self-efficacy, and well-being. We challenge the traditional view in rehabilitation that participation is merely the outcome of successful intervention. Rather, participation is better viewed as both a means and an end in the intervention design. In particular, interventions that enhance both attendance and involvement aspects of participation will prove most beneficial across psychosocial and physical domains.

Discussion and conclusion
We will propose directions for research that will advance our understanding of how positive participation outcomes can be enabled in DCD and related conditions. A strength of this framework is its ability to link constructs (environmental, biological, psychological and social) and its applicability to children with a range of neurodevelopmental conditions.
We12BFit! Improving physical fitness and lifestyle physical activity in 7-12 year old children with developmental coordination disorder (DCD)

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Background and aim

To describe the effectiveness of We12BFit!, a family focused intervention to increase physical fitness (PF), motivation for physical activity (PA) and, indirectly, improve lifestyle PA in 7-12 year old children with DCD.

Method

The intervention was evaluated in 19 children aged 7-12, with severe, moderate or probable DCD recruited from rehabilitation centers and schools for special education. During the intervention the participants engaged in a ten week group training, twice a week for one hour. Exercises focused on improving cardiorespiratory fitness (CRF), muscle strength and anaerobic power. Six weeks in to the training sessions a family-focused lifestyle PA intervention was added, which ended 12 weeks after the last training session. Motivation for PA was targeted through application of behaviour change strategies. Effectiveness was assessed at three instances (T0 before the training, T1 after the training, T2 after the lifestyle intervention) using 20 meter Shuttle Run Test, Muscle Power Sprint Test and Hand Held Dynamometry. Training intensity was monitored with heart rate monitors, if necessary the intensity was adjusted. The lifestyle intervention was evaluated using interviews with participants and coaches.

Results

Analysis revealed significant improvements in CRF from T0 to T1. Positive trends were found for mean power, elbow flexion, knee flexion, however significance of the effects was not retained after Bonferroni correction. Handgrip strength, elbow and leg extension did not improve significantly. From T1 to T2 PF seemed to stabilize as there were no significant differences. During the interviews parents indicated that they were able to meet the goals they set (e.g. finding a suitable sport, increasing active transportation). In addition, they stressed that the training intervention was of particular value in increasing their child’s self-esteem, perseverance and participation in PA.

Discussion and conclusion

We12Bfit! has the potential of improving PF and participation in activities in children with DCD.
Participation of children attending special education in sports and physical education

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Background and aim

We developed a handbook with examples on how to improve motor learning and participation in sport and exercise of children with motor difficulties. These examples are based on implicit learning principles. Starting from the conceptual model for childhood participation (Imms et al., 2017) we studied the relations between participation in leisure time sports and physical education (PE) in children attending special education. This included children with DCD, CP, and other (developmental) movement disorders.

Method

Children from nine school for special education, aged 9-18, were asked about their enjoyment and participation of PE lessons (n = 71), their self-efficacy towards physical activity (n = 44), their participation in organized sports in their free time (n = 101), and the perceived barriers and reasons (from the parents perspective, n = 101) to be physically active in their free time. In addition, we also performed observations during the PE lessons to determine key aspects in the context that may be related to the experience of participation.

Results

Results will be presented at the conference.

Discussion and conclusion

The outcomes of this study will be discussed in light of the participation model that is outlined by prof. Wilson in this symposium. In addition, we will discuss how the handbook can be used to improve participation of children with motor difficulties in sports and physical education.
Development and pilot testing of a tablet application to improve motor and sport-specific skills and promote sports participation in children with Developmental Coordination Disorder

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Background and aim

Children with Developmental Coordination Disorder (DCD) are physically less active and are less likely to enjoy participating in playground games, physical education classes, and sports activities compared to children without motor difficulties. The challenges of achieving behavioural changes in this group has prompted researchers to explore novel and engaging intervention strategies. One such approach is the use of eHealth technology (e.g., internet, smartphones, tablets) to encourage children to develop motor skills, physical activity behavioural skills (i.e., self-monitoring and goal setting) and stimulate sports participation. Study aims to describe the development and pilot testing of a tablet application (app) designed to improve motor and sport-specific skills with the ultimate goal to promote sports participation in children with DCD aged 6-12 years.

Method

An app was developed to support the delivery of a remedial motor and sport-specific skills program with a focus on self-regulated learning and applying motor learning principles such as using small steps toward mastery of a skill. During the first phase of the study, we pilot tested the program in a quasi-experimental design with one control condition (N = 30). Both the program and the care-as-usual condition were delivered for 16 weeks, with one session per week lasting 45 minutes, added with homework sessions. Eight self-chosen skills of importance to the child were the focus of the program. In phase 2, we tested a refinement of the program (N = 26) aimed at improving its feasibility and effectiveness. Feasibility was assessed using interviews with the children and teachers.

Results

We found no differences between the intervention and the care-as-usual group, but most children improved their motor performance, while self-regulation skills remained on the same level. Concerning sport-specific skills, all children in the intervention group improved on the self-chosen skills. In accordance with previous intervention studies in children with DCD, we found large intra-group variability in the change in motor performance and self-regulation. The interviews showed that children really valued being able to practice self-chosen skills. Another key factor of the program was the experience of success by breaking a skill into small, incremental steps.

Discussion and conclusion

This study provides preliminary evidence to support the use of an app within interventions for children with DCD. We argue that is important to involve children with DCD in the decision-making process. However, further research is needed to better understand which children with DCD are most likely to benefit from such interventions.
Do children with motor difficulties benefit from an external focus instruction to execute a motor task?

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Background and aim

Over the past two decades, numerous studies have shown that instructions promoting an external focus of attention (EFA) resulted in more effective execution and learning of motor tasks than did internal focus of attention (IFA). However, studies with children have shown somewhat mixed results. An interesting question is whether the central neuromotor deficits found in these children may limit the effects of an attentional focus instruction.

Aim. The purpose of the study was to examine whether EFA instructions would be more beneficial than IFA instructions for the execution of a task that required whole body coordination in children with motor coordination difficulties.

Method

Based on the MABC-2 test, 9-10 year-old children with motor difficulty (MD; < 16th centile) (n = 18) and typically developing children of the same age (TD; \&\#707; 15th) (n = 21) were identified. In a 3 (focus condition) x 2 (group) experimental design, MD and TD children performed countermovement jumps (using the Optojump Next device) under 3 different instructional conditions: external focus of attention (EFA, focus on getting as close to the ceiling as possible), internal focus (IFA, focus on the swing of their arms), and control (Con, no focus instruction). Whole-body kinematic analysis was carried out (SW Dartfish v6.0) based on the biomechanical model of vertical jump (Aragón-Vargas, & Gross, 1997).

Results

Jump height and vertical take-off velocity of the greater trochanter were significantly greater with an EFA compared to an IFA (17.70±3.91cm vs. 16.94±4.02 cm; p = .046, d = .19; and 203.45±34.98 cm.s\(^{-1}\) vs. 191.76±37.57 cm.s\(^{-1}\), p = .008; d = .32), but not as compared to the Con condition. The interactions of attentional focus and group were not statistically significant for jump performance and all kinematic variables (p >.05).

Discussion and conclusion

The study suggested that EFA is more favourable for children with impaired motor coordination than an IFA to execute a motor task that required whole body coordination. The effect was similar to TD children although DCD is associated with deficits in feedforward motor control or sensory-motor coupling (Wilson et al., 2013). Thus, the advantages of an EFA for motor performance and control are generalizable across levels of motor competency. Providing children with DCD with external focus instructions, rather than internal focus instructions, can enhance the performance of whole-body motor skills and learning in educational and clinical practice.

Keywords: instruction, motor impairment, focus of attention, jumping
Transfer of motor skills in children with DCD: Do we know enough?

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Background and aim

Lately, there has been a surge in the number of studies investigating motor learning in children with Developmental Coordination Disorder (DCD). Several investigators have compared learning rates between children with and without DCD. Others have examined procedural learning, and the effects of practice or training methods on skill acquisition. Most of these studies have demonstrated comparable learning in children with DCD and those with typical development (TD). However, little is known about transfer of learning in children with DCD. Transfer of learning (TOL) is conceptualized as the gain or loss in the ability for performance on one task as a result of practice on another. A fundamental goal of training in DCD management is to equip the child with skills to deal with various task demands in real world contexts. Therefore it is necessary to understand TOL to be able promote effective transfer of skills in this population. Aim was to determine the extent to which performance on a novel task is influenced by previous experiences in related skills (trained in variable practice context) between children with and without DCD.

Method

33 children with DCD and 28 typically developing peers (aged 7-12 years) participated in variable practice of selected Wii games scheduled 30mins per session, twice weekly for 10 weeks. Participants also played three trials of the Wii-Slalom game (transfer task) once weekly throughout the training period. Participants’ performance on the criterion task was compared to determine the differences in skills transfer between the groups.

Results

Both groups showed significant improvements in performance on the transfer task [F (1,51)= 9.507, p= 0.0001, eta squared=0.627]. However, children with DCD demonstrated less gains in performance than TD children [F(1,59)= 4.892, p= 0.031, eta squared=0.077]. The gap in skill transfer between the groups widened over time. This was evident by the outcome of the group by time interaction analysis [F(1,51)= 2.181, p= 0.039, eta squared=0.278].

Discussion and conclusion

Findings confirm that precious experience may facilitate the learning of new but equivalent tasks in both children with and without DCD. However, the fact that children with DCD and their TD peers demonstrate comparable learning, but different performances in transfer situations suggest that children with DCD may be less efficient in applying acquired skills to new contexts.

Keywords: Transfer of motor skills, Developmental coordination disorder, motor learning
The efficacy of a Task-Orientated Intervention for children with comorbid Developmental Coordination Disorder

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Background and aim

Among children with neurodevelopmental disorders, it is understood that comorbidity is the rule, not the exception. These children experience more severe functional and health-related problems than children with isolated conditions, yet they are often excluded from studies evaluating the effects of interventions. This study is the first to explore the use of a group-based, Task-Oriented Intervention (TOI) among children with comorbid Developmental Coordination Disorder (DCD) attending a Special Education School in South Africa.

Method

A quasi-experimental design was followed using the Movement Assessment Battery for Children-2 (MABC-2), to evaluate change in motor performance. Children aged 6–10 years, with a primary or secondary diagnosis of ADHD, Specific Learning Disorder, Autism, Behavioural Disorder and DCD (defined as a score <16th percentile on the MABC-2 and functional motor problem using the MABC-2 checklist) were included. Children were allocated (non-randomised) to receive either the TOI (n = 18) or Usual Care (n = 18) by teachers. Usual Care (UC) comprised of occupational therapy support either within the classroom, or in small group. The TOI program was implemented by a physiotherapist and assistant for nine weeks, twice a week, for 45-60 minutes per session. Pre and Post test scores were compared.

Results

At pre-test, no significant differences were found between the groups in terms of mean age (TOI: 9.14 years vs UC: 9.51 years; t=0.91, df = 34, p= 0.37), gender distribution (TOI: 14 boys vs UC: 13 boys; Chi2 = 0.148, df = 1, p = 0.7). Following the intervention, the overall motor performance, revealed that the TOI group improved more than the UC group (TSS mean difference= 1.33 ± 1.37; t= 4.12, p < 0.001) and that the effect was large (d= 0.95). Using the smallest detectable difference (SDD 95 per cent) of two standard scores as the cut-off, it was determined that nine of the 18 children who received TOI improved their TSS.

Discussion and conclusion

The results of this study showed that a TOI, delivered in small-group format, had a positive effect on motor performance in children with comorbid DCD. The effect size was smaller in this study than other studies investigating similar approaches. This could be due to the impact of comorbidities on time-on-task within the intervention sessions as the TOI therapist spent a significant portion of each session controlling for behaviour. Further research is needed to determine if children with comorbid DCD can make greater improvements by adjusting practice schedules.

Keywords: comorbidities, Task-oriented approach, DCD

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Efficacy of CO-OP with and without parental coaching on activity and participation of children with developmental coordination disorder: a parallel randomized clinical trial

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Background and aim

Children with DCD have trouble performing activities which might reflect negatively on participation. CO-OP is recommended for its effectiveness, and since parental support is a key element to support children’s occupational performance and meaningful participation, parental coaching seems relevant to be investigated. Aim was to investigate and compare the efficacy of CO-OP Approach with and without additional parental coaching to improve activity and participation in children with DCD.

Method

Randomized clinical trial with seven to 12-year-old children with DCD. Children were randomly assigned to experimental (E) or control (C) groups. Both groups received traditional CO-OP, 12 sessions, and (E) received four additional parental coaching sessions in group. Occupational performance and satisfaction for three trained goals was measured at baseline (T1), post-intervention (T2), and at 3-month follow-up (T3); and participation assessed at baseline (T1) and post-intervention (T2). Motor performance and executive function were assessed at baseline (T1) and post-intervention (T2). Children were computer-randomized into two groups, 11 children each. Parents and main investigator were not blind to group assignment, while children, external evaluators and those analysing the data were blinded to allocation.

Results

Children (n=22) mean age 8.96 (±1.09), IQ 97.46 (±14.60), MABC-2 percentile ranging 0.5 to 9th, in two groups (n=11), were equivalent at T1, except for age, as the control group was older (p=0.038). As a group (n=22), there were statistically significant differences between T2 and T1 (p = 0.000) on occupational performance and satisfaction for children and parents, and for occupational performance scored by external evaluators, with large effect sizes (d ranging 1.69-3.73). At T3 there were no statistically significant differences from T2. Regarding participation, there was a statistically significant difference in the level of involvement in activities at home at T2 (p = 0.018), with small effect size (d = 0.12). Regarding time-group interaction, there were no group differences, except for children’s satisfaction on group (E).

Discussion and conclusion

Coaching did not add additional gains, but children’s satisfaction was higher in group (E). As parents participated in most therapy sessions, this might be enough to support children’s activity and participation. In general, parents in both groups had good to optimal parenting style which might also have contributed to the equivalence on the outcomes. Trial registration: www.clinicaltrials.gov/NCT02893852.

Keywords: occupational therapy, intervention studies, family-centered, motor skills disorders
"I thought you would never do it, but now you can": The experience of children with motor difficulties participating in Cognitive Orientation to Daily Occupational Performance

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Background and aim

To investigate children’s perceptions about their participation in occupational therapy using the CO-OP approach. Children with Developmental Coordination Disorder (DCD) have difficulty participating in activities that require motor skills, which impacts on their social participation and self-esteem. Cognitive Orientation to Daily Occupational Performance (CO-OP) Approach is an effective intervention to improve performance on daily functional tasks in children with DCD. A number of quantitative studies support the approach’s efficacy, but the participants’ experience with the intervention, especially the children’s voices, have not been heard.

Method

Descriptive qualitative study with 14 children with DCD, ages 6-10 years old, who participated in a regular CO-OP approach program of 12 individual occupational therapy sessions. Post-therapy, focus groups of three to four children were organized to collect information on their perception of the therapy. Focus groups were conducted in a room at the university’s clinic, guided by an occupational therapist familiar to the children, but not their CO-OP therapist. Each child participated in a single group and the method was adapted to facilitate the children’s expression. All groups were recorded, transcribed verbatim, and the transcripts were submitted to thematic analysis.

Results

Thematic analysis revealed two main themes. In the first theme "Therapy process – what was difficult became easy" children talked about their increased motivation as they perceived their abilities and how much they valued learning things of their interest. CO-OP’s approach global cognitive strategy was considered a learning facilitator that was used outside therapy. Active parental participation was also valued. In the second theme "What changed in the children’s life – now I can" children reported on how becoming more independent in daily activities resulted in positive feelings about themselves.

Discussion and conclusion

Adapted focus group methodology allowed to capture the children’s experience with their participation in CO-OP. Children reported on their increased motivation to participate in therapy as activities that were difficult became easy. They valued the basic elements of CO-OP, such as strategy use and parental participation. This study adds information on the impact of becoming independent in daily tasks on children’s lives and the positive feelings that result from it. The wealth of information generated by the participants supports the idea that, with proper methods, children are able to express themselves and provide useful information. We should always think about creative ways to give them a voice and also consider including them as partners in research studies.

Keywords: Cognitive Orientation to Daily Occupational Performance (CO-OP), Child, Occupational Therapy, Qualitative Research
Best practices of assessing children’s play and peer interaction skills using easy hands-on digital tools

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In this workshop we will introduce digital RALLA tools (The Play Performance Assessment in Group Settings, PAGS, and Peer Interaction Skills Assessment, PIA) which are both used as child’s participation measures. Enhancing participation has been in the center of rehabilitation and pedagogical approaches while working with children who have learning challenges, for example, DCD. Anyhow, there has been lack of valid tools focusing to measure participation (attendance and involvement) of a child.

This workshop is designed for researchers and professionals in need of valid tools to enhance their work with children. Main aim is to provide information on how to observe and assess children’s participation by focusing to play and peer interaction skills. This interactive workshop is enabling experiences sharing and piloting the RALLA tools in interaction with others. The workshop has three section: We introduce (1) the theoretical perspective of measuring participation, (2) the digital RALLA tools, and (3) case examples how the PAGS and PIS can be used as outcome measures with child with DCD.

The validity and reliability of the RALLA tools was confirmed in several research projects. While validating the PAGS the two faceted Rasch model was used to examine the internal scale validity and the person response processes, and the three-faceted Rasch model was used to study the rater consistency and severity estimates. The stability of the individual measures of the children’s play performance was investigated with intra-class correlation (ICC). The internal scale validity of the PIS has been studied by using explorative factor analysis (Cronbach &\(^{945}\), PAF, Promax rotation). The rater consistency with both of the tools has been confirmed (PAGS, Rasch, severity and goodness-of-fit, and PIS, inter- and intra-rater correlations). Participators in these studies were children with specific language impairment (SLI) or ADHD, and typically developing children (TD). Future research is needed with children with DCD. Anyhow, there is evidence that children with DCD are often isolated from peer play interaction.

RALLA software is prepared to provide the statistical analysis model (Rasch) into practice, and to support consistent documentation after observation. Digital tools provide the opportunity to use RALLA tools also as outcome measures in practice. Supporting the development of play and peer interaction skills can benefit significant long-term impacts on participation. Use of valid and reliable tools used, for example, in early education facilities ensure high-quality impact in everyday life close to the child.

*Keywords: peer interaction skills, assessment, play skills, participation*
The Handwriting Legibility Scale (HLS): a practical new tool for a quick assessment of legibility of the written product

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Background. Demands for the production of fast and legible writing increase as children progress through school and beyond. Handwriting difficulties, including poor legibility are very common in children with developmental disorders, including Developmental Coordination Disorder (DCD). Such difficulties can hamper progress in education and later employment. In recent years, various assessment tools have been developed for holistic and or/analytic analysis of the written product. However quick, easy to use and practical tools for teachers and clinicians to determine the legibility of the written product are still lacking.

Aim and Purpose. The aim of this workshop is to introduce the Handwriting Legibility Scale (HLS), a short one page rating scale that is quick and easy to use to help identify those with handwriting difficulties. The workshop will provide delegates with some 'hands on’ experience in using this new tool. They will be given the opportunity to evaluate the HLS and discuss its possible use in their own practice and/or research.

Description of the tool. The HLS has been developed for use world-wide, across different languages and scripts. The assessment is based on a piece of ‘free writing’ of approximately 10 lines generated from a writing prompt. Currently designed for assessing the handwriting of students aged 9 years and over, the HLS combines global and detailed features of legibility. Drawing on professional expertise and a review of the literature, the HLS includes five criteria for the assessment of legibility: global legibility, effort required to read the script, layout on the page, letter formation and alterations to the text. Each is scored on a five point scale (1 to 5) and summed to give a total score, with higher scores reflecting poor legibility. Categories have also been established to reflect average, borderline and poor legibility scores. Aspects of reliability and validity of the scale have been examined in the UK and found to be good. Further work on the psychometric properties of the HLS is currently underway in Israel.

Practical relevance. The HLS may be a useful tool to identify those with poor legibility, to quantify levels of performance and to help plan how best to support individuals with poor handwriting. It may also be useful as an outcome measure following intervention. Given the global nature of the assessment of legibility in this new tool, the HLS is likely to be applicable across different languages and scripts.

Keywords: Assessment, Legibility, Handwriting
Is early intervention for children with movement difficulties feasible and effective when delivered by support staff with minimal specialist support?

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**Background and aim**

The primary aim was to evaluate the feasibility of an intervention program delivered in children with DCD by trained teacher assistants (TA's) with minimal specialist support. Secondary aims were to evaluate the effects on motor skills and functional activities. Regular provision of specific treatment for children with DCD is impossible due to limited resources. However, intervention programs delivered by teachers have been shown to be effective. We piloted a program in nursery schools where teachers identified children with DCD and TA's delivered an intervention program with minimal support from a therapist. This proved to be effective in improving motor skills. In this study we piloted that program with primary school children.

**Method**

Children were selected from primary schools using cluster sampling; some schools acted as the experimental/treatment and others as the control/no treatment groups. Teachers nominated children that had movement problems and completed, with parents, the Movement Assessment Battery for Children (MABC) 2 checklist following the procedure by Sinani et al. (2011). Children scoring ≥85th percentile were assessed by a blinded researcher. Ten children (7 boys, 3 girls) formed the control and 16 children (10 boys, 6 girls) the experimental groups, aged from 5-8 years. School Group Intervention: 6 weeks (3 times/week, 15-20mins) delivered by trained TA's covering 8 areas. All children completed the MABC-2 test and checklist before and after treatment; school attendance was also recorded. Analyses Baseline: Three one-way ANOVAs were carried out separately for age, overall score on the MABC-2 test and checklist; Chi-square (gender differences). Between group comparisons: repeated measures ANOVA 1 between factor (group) x 2 within factors (time, subtests). Within group comparisons: paired t-tests. P was set at .05.

**Results**

Groups were balanced at baseline. Repeated measures showed significant differences for subtests \( F(2, 63) = 3.74, p<.05 \) whereas time approached significance \( (p=.06) \). When school attendance was used as a covariate, the subtests was non-significant \( (p=.371) \); time was at \( p=.254 \). Paired t-tests showed significant differences for the overall score for the MABC-2 test \( (t(15)=-2.21, p<0.05) \) only for the experimental/treatment group.

Discussion and conclusion

It is feasible to deliver an intervention by trained TA's with minimal specialists’ support in a group of children having movement problems. Children who received the intervention improved their motor skills. Attendance influenced the outcome.

**Keywords:** school programme, minimal specialist support, teacher(s) assistants, Intervention
Characteristics of developmental coordination disorders for fine motor skill in 5-year-old children: A 2D video tracking analysis system

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Background and aim
The present study sought to elucidate difficulties in fine motor performance and the factors associated with problems in children with developmental coordination disorders (DCD). We examined 5-year-old Japanese children using a simple 2D video tracking analysis system.

Method
This study was carried out as part of the Hirosaki Five-Year-Old Children Developmental Health Check-up Study in 2017. We examined a sample of 18 children diagnosed with DCD, and 21 children classified as typically developing by pediatricians and psychiatrists using DSM-5 criteria. For 2D video tracking analysis, a single web camera was positioned above children’s hands and recorded during the M-ABC2 posting coins task. We stuck an 8 mm black seal on the center of children’s dorsum manus as a tracking marker. The marker point was tracked during the first trial by the dominant hand using form analysis software (Kinovea). We then calculated average speed, average acceleration and total trajectory length. To evaluate factors associated with fine motor performance, children also were assessed using the grip strength test and the finger to nose test. Differences in 2D video tracking data (average speed, average acceleration and total trajectory length), average grip strength and correct answer rate on the finger to nose test between the DCD and TD groups were analyzed. In addition, correlation analyses were used to determine the relationships between scores on the M-ABC2 posting coins task, 2D video tracking data, and other factors.

Results
The average speed was significantly slower, and the total trajectory length was longer in the DCD group than the TD group (p < 0.05). The DCD group also scored worse on average grip strength and the correct answer rate of the finger to nose test (p < 0.05). A significant correlation was found between scores on the M-ABC2 posting coins task and average grip strength (r = 0.365, p < 0.01).

Discussion and conclusion
The current results suggest that children with DCD exhibit slowness and extra movement in fine motor performance, weaker grip strength, and various problems in the sense of position and movement. Moreover, overshoot dysmetria appears to point to some degree of dysfunction in the brain. This issue should be further investigated to consider other comorbidities, including autism spectrum disorder (ASD) and attention deficit hyperactivity disorder (ADHD).

Keywords: Fine motor skills, Extra movement, Video tracking, Motor speed
Differentiation of motor and attentional deficits of Developmental Coordination Disorder and Attention-Deficit Hyperactivity Disorder: an EEG study

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Background and aim

Developmental Coordination Disorder (DCD) and Attention-Deficit Hyperactivity Disorder (ADHD) have a high comorbidity rate, and both disorders can present deficits in attention and motor skills. The extent to which the comorbidity rate influences the overlap of symptoms has not been thoroughly studied. Previous research suggests that co-occurring ADHD does not account for all attentional difficulties among those with DCD, however, these studies have not isolated attention and motoric behavior. Studies of ADHD rarely screen for comorbid DCD and it remains unclear if some of the motor impairments of ADHD are attributed to comorbid DCD. Furthermore, existing studies examining the differentiation of comorbid DCD + ADHD versus single-occurring DCD or ADHD have not explored differences in neural activity with Electroencephalography (EEG) and are exclusively based on child samples to our knowledge. Therefore, the purpose of this ongoing study is to utilize behavioral tasks and EEG to record electrical brain activity in order to tease apart the fine motor behaviors and attentional patterns among N = 144 adults with either DCD, ADHD, comorbid DCD + ADHD, or typically developing controls.

Method

Participants are asked to complete several computerized tasks (e.g., the Stop-Signal Task), which engage both attention and fine motor activity, while EEG is recorded.

Results

We expect that each clinical group will display significantly different event-related potentials (ERPs) during their motor responses and brain wave activity indicating attentional differences when compared to the control group. We expect these differences to also be evident in diffusion model analysis, a method used to differentiate the motor response from cognitive factors (e.g. attention) for behavioral data. Preliminary results will be presented on the differences across groups in EEG data and diffusion models.

Discussion and conclusion

This study provides the unique contribution of examining the DCD, ADHD, and DCD + ADHD groups with analyses of EEG measurements. We also take a novel approach by assessing performance of all groups with diffusion models. This approach is important because adults likely develop compensatory strategies to function with DCD and/or ADHD which may not be detectable in general behavioral data alone. Overall, the combined methods take a necessary novel approach toward understanding the overlapping symptoms in DCD and/or ADHD in adults, and can inform future differential diagnosis between these two disorders.

Keywords: Electroencephalography, symptom differentiation, Developmental Coordination Disorder, Attention-Deficit Hyperactivity Disorder
**Persistence of coordination problems from childhood into middle age. A 40-year cohort study**

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**Background and aim**

Developmental coordination disorder has been reported to persist into late adolescence or early adulthood in approximately half of diagnosed patients. To our knowledge, people with childhood coordination problems have not been followed up beyond the age of 18. We studied to what extent childhood coordination problems affect motor functions in midlife.

**Method**

As part of a prospective cohort study, we studied 304 community-dwelling adults who had been exposed to perinatal risks. At the age of 9 years, their coordination skills had been examined with Stott’s Test of Motor Impairment: 236 had normal coordination, 52 had moderate problems, and 16 had marked problems. At the age of 40, we assessed their balance, manual dexterity, and visuomotor skills using, respectively, the Balance Error Scoring System, the 9-Hole Peg Test, and the Coding subtest of the Wechsler Adult Intelligence Scale-IV.

**Results**

According to bootstrapped ANOVAs, the marked-problem group had worse postural balance (p < .001), manual dexterity (p < .001), and visuomotor skills (p = .030), as compared to the normal-coordination group. The marked-problem group also had worse balance (p = .001) and manual dexterity (p = .003) than the moderate-problem group. The moderate-problem group did not differ from the normal-coordination group on any of the measures.

**Discussion and conclusion**

In people exposed to perinatal risks, marked coordination problems of childhood still manifest in midlife as performance deficits of motor functions. This demonstrates the often chronic course of marked coordination problems in childhood and highlights the necessity of careful follow-up.

*Keywords: adults, follow-up, cohort, coordination*
Pre-handwriting skills and Executive Function in pre-schoolers

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Background and aim

Handwriting is a complex task and requires integration of cognition, graphomotor skills and Executive Functions. The role of handwriting automation and EF in the writing process is known primarily from school-based studies: there is a relationship between handwriting and EF in learning writing skills, particularly in the early years of primary school. The link between the emerging writing skills and EF in pre-schoolers isn’t so evident though. Identifying the relationship between these skills can help provide better support for children who have handwriting difficulties, as well as children with DCD. The purpose of this study was to examine and describe the relationship of pre-handwriting skills and the EF in pre-schoolers, such as Working Memory and Planning/Organization of the actions involved in the handwriting process. The study aimed to outline the developmental progress and possible gender effects underlying the processes.

Method

166 typical developing pre-schoolers (aged 39 to 71 months) performed Shore Handwriting Screening (SHS), an assessment tool to evaluate pre-handwriting in children through tasks like drawing, colouring, copying of images and letters and cutting. 60 of them (aged 39 to 59 months) performed the Executive Function Battery for pre-schoolers (BAFE), this 4-task test consists of stroop-effect cards, pattern-making, card-sorting and ‘spin the pots’ Meanwhile, parents answered the Behavior Rating Index of Executive Function (BRIEF-P).

Results

The results showed significant age and gender effects in pre-handwriting skills: older children performed significantly better than younger children and girls performed better than boys in the SHS tasks. Regarding EF, the indirect measures (BRIEF-P) showed no differences between age groups. The direct measures (BAFE) showed that 4-year-olds performed significantly better than 3-year-olds. No gender differences emerged. Pre-handwriting skills and EF appeared significantly correlated both direct and indirect measurements. In particular the SHS total score correlated with the Emergent Metacognition Index (BRIEF-P) and with ”pattern-making” (BAFE). Children who have better Working Memory and Planning/Organization skills are the children that have better performances in pre-handwriting tasks.

Discussion and conclusion

Our data indicate a relationship between pre-handwriting skills and EF in pre-schoolers. To our knowledge, this relationship has been little investigated in literature in this age group. Our results could therefore be important to interventions with poor pre-handwriting children and to better understand the skills implicate in the writing process before primary school.

Keywords: preschoolers, pre-handwriting, executive functions
Parent Reports are a Valid Measure of Academic, Motor, and Cognitive Abilities in Children with Developmental Coordination Disorder

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Background and aim

Parents are a potentially rich source of information about a child’s development and previous research supports the validity of parent reports. Parent questionnaires are commonly used as an aid in the screening for and diagnosing developmental disorders. Limited research, however, has investigated the validity of parent perceptions of children’s development in children with developmental coordination disorder (DCD). The primary aim of this study was to examined the associations between parent ratings of academic, motor and cognitive abilities, and children's performance on standardized measures, in both children with DCD and typically developing (TD) children.

Method

227 children, aged 6-18 years, were recruited for the current study. 133 children were classified as DCD and 94 children were classified as TD using the Movement Assessment Battery for Children- Second edition (MABC-II). Parents completed the Parent Ratings of Everyday Cognitive and Academic Abilities (PRECAA) questionnaire. The children participated in a standardized assessment which included: the Wechsler Individual Achievement Test- Second Edition (WIAT-II), the McCarron Assessment of Neuromuscular Development (MAND), and Developmental Neuropsychological Assessment – Second edition (NEPSY-II). Correlations were run between PRECAA subscale scores and children’s scores on each standardized assessment measures for all participants and for the DCD and TD groups separately, controlling for age, sex, and Connors Rating Scale-Revised (CRS-R) scores of attention. The correlations between parent ratings and standardized scores were compared between the DCD and TD groups using Fisher’s r-to-z transformation.

Results

Parent ratings were significantly correlated with subtest scores on the WIAT-II, MAND, and NEPSY-II for all participants. Significant correlations were also observed when the DCD and TD groups were examined separately. Few group differences were observed in the strength of these correlations.

Discussion and conclusion

Parent ratings of their children’s abilities were found to be related to children’s motor, academic and cognitive performance. These findings suggest that parent ratings on the PRECAA are a valid and useful means of assessing these abilities in children with DCD and could aid in screening children with DCD for academic and cognitive problems.

Keywords: parent reports, cognitive abilities, academic abilities, motor abilities
Signs of anxiety in children with and without Developmental Coordination Disorder: A preliminary study

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Background and aim
To evaluate signs of anxiety in children with severe and moderate developmental coordination disorder (DCD) in relation to their peers without DCD. In addition, to compare signs of anxiety between genders and age groups.

Method
Participants were assessed following the DSM-V diagnostic criteria for DCD. Those who met the DCD criteria were classified into two groups: severe DCD (s-DCD) and moderate DCD (m-DCD) and those without DCD were classified as typically developing children (TD). The participants were 61 children, in which 26 with severe DCD (aged 9.23 ± 0.76, 13 girls), 19 with moderate DCD (aged 9.15 ± 0.83, 10 girls) and 16 typically developing (aged 9.06 ± 0.92, 12 girls). Motor performance was evaluated through Movement Assessment Battery for children – 2 (MABC-2) whilst the Spence children’s anxiety scale (SCAS – children version) was used to identify the signs of anxiety.

Results
Boys reported more signs of anxiety (55.2%), but no significant differences were observed between genders (p = 0.06). The youngest children (8 – 9 years old) reported more signs of anxiety (51.7%) than the oldest ones (10 years old), whose reported 48.3% of those signs. Similarly, no significant differences were found (p = 0.39) between ages groups. The SCAS total score for each group was: 57.96 ± 8.66 for s-DCD; 58.21 ± 8.49 for m-DCD and 57.31 ± 10.46 for TD group. Differences among these three groups were not significant (F1,62 = 0.04, p = 0.95).

Discussion and conclusion
No significant differences about signs of anxiety between groups, genders and age were observed. Whereas other studies have showed that anxiety is more prevalent in children with DCD comparing to their peers without DCD, we presume that the anxiety scale used in this study may not be sensible enough to evaluate Brazilian children. Thus, complementary assessments should be applied, i.e. with regards parents and teachers answers. Conversely to the previous studies regarding signs of anxiety in children with DCD, our preliminary findings indicated normal levels of anxiety in these children. Yet, considering the consequences in daily, academic and social activities, more studies which address this thematic are recommended. Lastly, using sensible and complementary scales are necessary in order to understand better the clinical signs of children with DCD.

Keywords: mental health, anxiety, emotional health, developmental coordination disorder
The effect of motor skills on cognitive control and anxiety

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Background and aim

Individuals with motor disorders engage compensatory cognitive control processes (Querne et al., 2008) and they are prone to increased levels of anxiety (Pratt & Hill, 2011). Currently, it is believed that anxiety in individuals with poor motor skills is associated with their negative experiences when interacting with peers (Cairney, Veldhuizen, & Szatmari, 2010). The study investigated a novel explanation focused on the cognitive control networks which may explain the predisposition for anxiety observed in individuals with poor motor skills.

Method

Thirty-five typically-developing adults completed the Bruininks-Oseretsky Test of Motor Proficiency (BOT-2-SF) and the Penn State Worry Questionnaire, reflecting generalised anxiety traits. Using electroencephalography (EEG), error-related negativity (ERN) and post-error slowing (PES) were measured to assess cognitive control during a Flanker task. Data collection is ongoing.

Results

Preliminary data analysis revealed a significant negative relationship between motor proficiency and anxiety (r=.390, p=.01). The relationship between ERN, reflecting cognitive control processes, and anxiety was close to significance (r=.365, p=.052). Additional data are being collected to enhance the power of the correlational analyses and to compare the ERN and PES between two groups from the sample: individuals with poorer and better motor skills. This will indicate whether individuals with poorer motor skills engage enhanced cognitive control processes.

Discussion and conclusion

Overall, anxiety is associated with motor proficiency in typically developing individuals, in line with previous research. With the use of a larger dataset it will be possible to determine whether the enhanced error control processes are utilised by individuals with poorer motor skills as a compensatory mechanism to facilitate task performance, as suggested by the literature in DCD. It may be possible that these processes predispose individuals to increased anxiety via enhanced sensitivity around making errors. This is a novel explanation for the occurrence of anxiety which may influence further research and intervention planning for individuals with poor motor skills.

Keywords: cognitive control, motor proficiency, anxiety
Occupational Performance Coaching for preschool children with sensorimotor and functional difficulties

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Background and aim

Many preschool children suspected with autism spectrum disorder (ASD) present sensorimotor and functional difficulties affecting their occupational performance. However, most of these children do not meet criteria for ASD assessment after screening and therefore, do not receive a diagnosis. Without diagnosis, many preschool children with sensorimotor and functional difficulties do not have access to occupational therapy in order to improve their occupational performance. Aim is to explore the effects of Occupational Performance Coaching (OPC) for preschool children with sensorimotor and functional difficulties that do not meet criteria for ASD assessment after screening.

Method

A multiple case study design was used. Each case included the child (n=7), his/her parents (n=8) and, whenever feasible, his/her educator from daycare (n=3). Data were collected between September 2017 and August 2018. Before the intervention, children’s characteristics (i.e. motor, sensory, functional and behaviors skills) were assessed with standardized tools. Occupational performance problems and individualized objectives were determined with parents and educators using the Canadian Occupational Performance Measure (COPM) and the Goal Attainment Scale (GAS). OPC was generally offered once a week during 7-10 weeks. The effects of OPC was measured with the COPM and the GAS after the intervention and 3 months post-intervention.

Results

Children (n=7) were aged between 4 and 6 years old and presented difficulties with sensory (6/7), motor (3/7), functional (6/7) or behavior (4/7) skills according to standardized tools. Individualized objectives (n=25) aimed to improve children’s performance or engagement in self-care (44%), social relationships (24%), play (20%), and writing (12%). After the intervention, 5 children showed a clinically significant improvement of their occupational performance (COPM) and 6 reached their goals (GAS). Three months post-intervention, all children showed a clinically significant improvement on the COPM and 5 maintained their goals on the GAS. The majority of the individualized objectives were reached after the intervention (84%) and maintained 3 months post-intervention (80%).

Discussion and conclusion

This study allowed a better understanding of the characteristics and the occupational performance problems of these children as well as their response to OPC. Findings will help to support the development of primary care occupational therapy for preschool children with sensorimotor and functional difficulties in order to meet properly their needs.

Keywords: Occupational Performance Coaching, functional difficulties, preschool children, sensorimotor difficulties
Using the DEMOST-PRE for identifying movement difficulties in 6-8-year-old children

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Background and aim

Several motor screening tools are utilized nowadays for identifying movement difficulties in children. Nevertheless, most of them are costly and create a rigid assessment environment. The Democritos Movement Screening Tool for preschool children (DEMOST-PRE) seems to be useful for educational settings, as it is time-effective (administration time $<$15 minutes), cost-effective (most of the equipment needed can be found in schools), as well as, easily administered and scored. Nevertheless, its unique characteristic is items’ presentation through short fairytales that motivate child’s participation. The DEMOST-PRE consists of 10 items (Tapping; Jumping repeatedly sideways; Running; carrying and placing a ball in a box; Toe-to-heel walking in a backward direction; Overhead toss to a specific target; Picking up coins and placing them in a box; Stepping through three vertical hoops; Catching a bean bag; Standing jump over a stick) and its total score can be converted into three descriptive categories (poor coordination; average coordination; above average coordination). The tool has been validated in Greek children aged 4-6 years and now it is being cross-culturally adapted in Estonia and Iran. The aim of the present study was to investigate if the DEMOST-PRE can identify movement difficulties in 6-8-year-old children.

Method

Forty-six children (26 boys, 20 girls), aged 76-95 months ($82.2 \pm 4.4$) participated in this study. All of them had been previously assessed with the Movement Assessment Battery for Children (M-ABC), with 21 having been identified with developmental coordination disorder (DCD). The DEMOST-PRE was administered to each child individually in an indoor area. To check the screening accuracy of the DEMOST-PRE, cross-tabulation analysis, as well as Gamma and Somer’s d coefficients were utilized.

Results

According to the results, the 21 children with DCD were classified by the DEMOST-PRE as having ”poor coordination” (100%). The rest 25 children were classified as having ”poor coordination” (4 [16%]), ”average” (15 [60%]) or ”above average coordination” (6[24%]). Gamma and Somers’ d coefficients were found to be 1.0 (p<.001) and .78 (p<.001), respectively, revealing an alignment between the above tools.

Discussion and conclusion

It seems that the DEMOST-PRE can accurately identify movement difficulties in 6-8-year-old children. Although its suitability for this age should be further checked, the DEMOST-PRE, being ecologically valid and sensitive to the examinee’s level of comfort, seems to can contribute to the timely identification of children’s movement difficulties.

Keywords: Democritos Movement Screening Tool for preschool children, screening, movement difficulties
Self-Care Development in children with and without motor impairments – a systematic review

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Background and aim
To generate new knowledge and evidence about the development of self-care in children with and without motor impairments. This will include identifying the variation and potential predictors in the development of self-care in children. Successful participation in self-care activities plays a key role in the balanced development of children and contributes to their health, wellbeing and participation in society. (1) Enabling the development of self-care in children with motor impairments is a core activity for children’s healthcare professionals however there is almost non-existent research in this area to guide therapists’ practice. (2) Further, little is known about the development of self-care in children with motor impairments in comparison to the development of this domain in typically developing peers. (3)

Method
A systematic review on factors influencing the development of self-care in children with motor impairments. For this study motor impairments is defined as impairments in neuromusculoskeletal and movement-related functions and the target population is children whose impairments in this domain impact on participation in self-care or activities of daily living. Conditions may include Developmental Coordination Disorder, Cerebral Palsy and Hypermobility Syndrome amongst others.

Results
Along with motor impairment and cognitive function the following factors play a role in self-care development: educational placement, maternal and paternal education, socio-economic status, home environment.

Discussion and conclusion
This study confirms that functional difficulties in children with motor impairments need to be understood in the context of family and environmental determinants in order to have greater understanding of and in order to address these difficulties. The significance of this study is the identification of specific factors that need to be taken into account when gathering information as part of the assessment process in children with motor impairments.

Keywords: Self-care, Occupational Therapy, early development
Terminology used by experienced physiotherapists to describe movement quality in infants and toddlers

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Background and aim

Some studies suggest that in prematurely born children developmental coordination disorder (DCD) and/or minor neurological dysfunction (MND) (both terms cover partly overlapping problems) can be predicted by qualitative General Movements Assessment. To our knowledge, there are no studies available investigating the predictive value of non-standardized observation of movement quality in infants and toddlers. Neither is it clear if the terminology used to describe movement quality is well-defined. The present study investigates if Belgian physiotherapists describe deviant movement quality in infants and toddlers in a consistent way.

Method

25 experienced Belgian pediatric physiotherapists enrolled in the study. Twenty short videos of children under the age of three were presented in three focus groups. Participants were asked to describe the observed movement quality in the videos and to discuss the terminology. Content analysis was applied to analyze the audio recorded focus groups using Nvivo 11 data analysis software.

Results

A great variety in terminology was used to describe the same motor behavior. Both concepts (dissociation/selectivity, planning & organisation, fine motor coordination, postural control, variation, fluency and balance) and descriptions (functional & analytic movements, amount of activity, changes of posture and symmetry) were reported as well as physiologic aspects (tone, reflexes, ROM, force, balance and orthopaedic aspects) and internal factors (mood, vision, sensory system and mental capacities). Little discussions occurred.

Discussion and conclusion

Quality of movement is a complex multi-layered construct. The used terminology is in overall compliance with previously described instruments on quality of movements. Physiotherapists all observe the same aspects when describing the quality of movement in infants and toddlers. The great variety in terminology and the occurrence of some discussions indicate the need of more clear concept definitions and descriptions.

Keywords: qualitative study, quality of movement, terminology, developmental coordination disorder
The adaptation process of the International Recommendations on Developmental Coordination Disorder (DCD) to Israel

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Background and aim
To describe the process and product of the adaptation to Israel of the 2016 revision of the International Recommendations on Developmental Coordination Disorder (DCD). In 2016 the International Recommendations on DCD, that were initially published in 2011, were completed. The recommendations are meant to establish evidence-based definition, etiology, diagnosis and intervention related to DCD for children and adolescents, so as to ensure best clinical practice and common ground for researchers. To this end, a specialist panel followed a Delphi process based on systematic literature reviews they conducted on topics such as underlying mechanisms of DCD, assessment and intervention related to DCD. Although the panel included a multidisciplinary team from over 20 countries world-wide, it was recommended that each country adapt the recommendations to their own health and education systems.

Method
The Israeli adaptation process focused on the recommendations for children. The process was initiated by two clinician-scientists, one of whom was a member of the international panel. Together with the head of the Child-Development and Rehabilitation department of the Ministry of Health, they formed an 18-member multidisciplinary panel including physicians and therapists, representing different health organizations and the educational system. After studying the International Recommendations, the Delphi panel members discretely voted on the different recommendations in 6 rounds. On two occasions the panel members met to discuss controversial issues that required specific attention, due to the unique structure of the Israeli health system. Consensus was determined at the level of 80% agreement.

Results
At the end of the process, the Israeli recommendations on DCD were established. Overall, the recommendations were similar to the International Recommendations. One issue that was revised was the age of identification of DCD (4- instead of 5-years-old) due to the age limitation of free health service provision to children with mild developmental disorders (up to the age of 9-years). Additionally, it was decided that a diagnosis of DCD will require the input of both a physician and therapists, due to the need to meet the four criteria of DCD definition.

Discussion and conclusion
The International Recommendations required few adaptations to the Israeli system, suggesting that these recommendations are sufficiently wide and universal. Thus, it appears that the recommendations may provide common conceptual and clinical practice guidelines for researchers and clinicians worldwide. However, support for this assertion requires input from additional countries regarding the adaptation of the International Recommendation on DCD.

Keywords: Intervention, Recommendations, DCD, Assessment
Relationship between M-ABC-2 scores and diagnosis of DCD

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Background and aim

Criteria for Developmental Coordination Disorder (DCD) are available in DSM-5. The EACD has developed diagnostic guidelines based on these criteria and suggests a score below the 16th percentile (Pc) on M-ABC-2 as a cut-off for criterion A in DSM-5. This study investigates the relationship between M-ABC-2 results and a diagnosis of DCD in a clinical high-risk population and the effect of age, IQ, prematurity, Autism Spectrum Disorder (ASD) and Attention Deficit Hyperactivity Disorder (ADHD) on this relationship.

Method

Data from children born between 2006 and 2011 and multidisciplinary assessed in the Center of Developmental Disabilities Ghent, have been retrospectively collected. Inclusion criteria were (1) no medical diagnosis known to have an impact on motor development, (2) an IQ above 70 and (3) M-ABC-2 score available.

Results

Out of 464 children, 154 children (33,2%) had a diagnosis of DCD and 83 children (17,9%) were at risk for DCD. In the group of children with DCD or at risk (N= 237), 33 children (13,9%) had a M-ABC-2 score above the 16th Pc. In the group of children without DCD (N= 227), 111 children (49%) had a score below the 16th Pc and 61 of them (26,9%) had even a score below the 5th Pc. Younger children had more frequently a score below Pc 16 without a DCD diagnosis. Children with lower IQ had lower M-ABC-2 scores. Children with a diagnosis of ASD had more chance to have a score below the 16th Pc and more chance for a diagnosis of DCD, even with a score above the 16th Pc. ADHD and prematurity had no significant effect on the relationship between the DCD diagnosis and M-ABC-2. The sensitivity of M-ABC-2 for DCD was 0.87 and specificity was 0,51.

Discussion and conclusion

This multidisciplinary team considers M-ABC-2 results in their clinical reasoning in DCD diagnostics, but not as a strict cut-off. Other important factors could be the evaluation of the interference of the motor skill difficulties with daily activities mainly based on the interview with the parents, the observations of movement quality (muscle tone, balance reactions, coordination..), the age of the child and possible comorbidities. Exceptionally a diagnosis of DCD was put forward without a significant decreased motor test score, more frequently in children with ASD. A difference between the group of children with DCD in research, adopting M-ABC-2 criteria strictly and the clinical group of children with DCD should be considered.

Keywords: test scores, diagnostic guidelines
Assessment of gross motor development of Japanese children using IT support tool

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Background and aim

The purpose of this study was to develop an information technology (IT) support tool for gross motor assessment and to examine the feasibility of using the tool for effective intervention for children with special needs.

Methods

We have developed an IT support tool that uses computer-assisted video processing. With this tool, users can easily search and view video images of child movement and evaluation results on the same screen. Data from a three-axis acceleration logger attached to a child’s arm were used as auxiliary information. A pilot study using the tool was conducted to assess the Test of Gross Motor Development Second Edition (TGMD-2) (Ulrich 2000) in Japanese children. Sixty children aged 3–6 years from a child development support center (n = 30) and a preschool (n = 30) participated. All TGMD-2 assessment trials were videotaped using two cameras and subsequently analyzed and scored using the IT support tool. We examined the method of intervention for children with special needs.

Results

Regarding the IT support tool, setting the cue of the video on the tablet takes time, so improvement is needed for automation. Once set, however, the evaluator could easily and conveniently input, search and correct assessment points while repeatedly viewing segmented images on the same screen. Moreover, it was easy to check and correct the evaluation results at a later time. Use of the IT support tool increased the opportunities for teachers to cooperate with their colleagues and other experts on assessment of gross motor development. The children who attend the child development support center are suspected of having development delays, so the scores for locomotor and object control skills were lower than those of the preschool children. As a general trend, children were good at kicking ball but tended not to be good at stationary dribbling. Especially, children with delayed exercise skills were recognized, and the teachers began to think about special support that could be implemented through ordinary childcare. Teachers were also able to offer parents clear advice on what exercises could be done at home.

Discussion and conclusion

We developed an assessment support tool using computer-assisted video processing. A pilot study conducted to assess the TGMD-2 in Japanese children revealed that the IT support tool expanded the possibilities for teachers and parents to support the children’s motor development.

*Keywords: 3-6 years, assessment of gross motor development, computer-assisted video processing, TGMD-2*
Do children with and without DCD differ in qualitative and quantitative measures of overarm throwing?

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Background and aim
As typically developing children gain throwing proficiency, their movement strategies change from those that maximize body stability (stability profiles) to those that allow for greater generation of accuracy and force (mobility profiles). To date, no one has examined how children with Developmental Coordination Disorder differ from their typically developing peers in this developmental process. Our study addresses differences in qualitative and quantitative characteristics of over-arm throwing between typically developing (TD) and children with probable DCD. We hypothesized that children with pDCD would exhibit motor strategies associated with greater body stability that ultimately result in lower throwing accuracy.

Method
74 children (36 F/38 M) between 7 – 11 years old participated in this study. All children were assessed using the Movement Assessment Battery for Children (MABC-2). In total, 37 (50%) met all four DSM – 5 criteria for DCD. Each participant completed 10 overarm throws with a ball adjusted to their hand size at an age-adjusted target distance. We assessed movement quality using the component approach (Halverson and Roberton, 1984) and quantity using target accuracy.

Results
The analyses revealed that the pDCD participants had significantly lower target hits (p < .01) as well as lower throwing accuracy (p < .01) than TD participants. In terms of developmental sequence components, the majority of the children with pDCD made a short contralateral step, exhibited no or a block trunk rotation, little backswing, and no differentiated arm action during forward swing, whereas the TD group demonstrated more advanced component actions. Additionally, pDCD demonstrated a higher percentage of stability profiles (49%) than TD (14%) as well as fewer mobility profile component combinations (6 for pDCD vs. 14 for TD). Finally, product scores tracked with process scores, such that children who threw using stability profiles hit the target less often and with less accuracy than children using transitional or mobility profiles.

Discussion and conclusion
Both qualitative and quantitative measures from this study clearly showed that children with DCD are at a disadvantage in controlling a ball during overarm throwing. We suggest that outcome variability (e.g. decreased accuracy) may not be indicative of performance variability in the case of the DCD group, but rather of be a function of performance fixation (e.g. not exploiting available degrees of freedom) once a movement solution is found.

Keywords: Developmental sequences, Accuracy, overarm throw
All in the family: Similarities and differences in prefrontal cortex activity among siblings with and without Developmental Coordination Disorder

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Background and aim

Functional near infrared spectroscopy (fNIRs) offers a powerful tool to examine brain function in individuals with developmental coordination disorder, because it can be used to monitor cortical oxygenation while participants actively engage in ecologically valid tasks. We had a unique opportunity to compare prefrontal cortex activity in three sets of siblings with varied DCD status performing a manual (3D) and computer (2D) version of the Tower of Hanoi (ToH). Our previous research has shown that 3D ToH requires greater PFC activation than 2D on a matched set of puzzles. We aim to examine hemodynamic differences in specific brain regions as a function of sibling pair, task and DCD status.

Method

A total of 14 children participated (8 non-familial TD and 6 siblings with at least one DCD diagnosis per pair: SS1 (brothers, 1 DCD); SS2 (twins, 2 DCD), SS3 (twins, 1 DCD). After completing the Movement Assessment Battery for Children 3, participants performed two ToH conditions: a wooden model (3D) and a computer model (2D). For each condition, participants solved the same set of TOH puzzles during three, one-minute intervals while fNIRs data were collected. We calculated changes in prefrontal hemodynamics (ΔHbO). Optodes were grouped into four regions representing the left dorsal, left medial, right medial, and right dorsal prefrontal cortex. Data were analyzed in R using a non-parametric statistical approach. Data from eight TD participants were used to create a reference distribution of randomly formed non-familial pairs. Each sibling pair was then compared to this reference distribution to determine their "sameness" as compared to the TD reference distribution.

Results

The sibling set with DCD (SS2) had extremely similar patterns of PFC hemodynamic change in 2D (right medial and lateral PFC) and 3D (right medial PFC) conditions when compared to reference distribution of non-familial TD pairs. SS1 exhibited extremely different patterns from each other in the 2D condition in overall ΔHbO, with most prominent in the left dorsolateral, left medial and right medial PFC, but were similar to each other in the RMPFC in 3D, potentially reflecting the higher cognitive load necessary to perform the 3D task. SS3, with one DCD twin, were extremely similar to each other in 2D but extremely different in 3D in the RMPFC.

Discussion and conclusions

In siblings, DCD status appears to affect changes in hemodynamics during different versions of the ToH task, particularly in the right medial prefrontal cortex.

Keywords: executive function, prefrontal cortex, fNIRs, Tower of Hanoi
Innovation of Eye tracking device for early detection of children with developmental coordination disorder

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Background and aim

Developmental coordination disorder (DCD) is one of neurodevelopmental disorders. According to recent review and meta-analysis, the pathology of DCD is mainly described by Internal Modeling Deficit (IMD) hypothesis, which consists of different effector systems. One of them is eye movement control (Adams ILJ 2013, Wilson PH, 2013, 2017). In this study, we investigated the eye movement of children aged 5 years using new eye tracking device.

Method

The subjects were 64 children (boys: girls=42:22) of 5 years old who participated in the Hirosaki Five-Year-Old Children Developmental Health Check-up Study in 2017. There were 30 children diagnosed with DCD (with/without comorbidity, DCDs), 14 had other diagnoses (ODs), and 20 had no diagnosis (NDs). The criteria for DCD met DSM-5 criteria, and the standard score in MABC-2 was set to 7 points or less. Eye movements were measured using an eye tracking device named Gazefinder by JVC KENWOOD Corporation. The tasks used were four Fixation tasks (windmill, grid, star, alligator), two Pursuit tasks (slow and fast), and two Saccade tasks (slow and fast). The total time of the video was 106 sec. For these tasks, gaze points for objects with a diameter of 30mm were plotted every 0.02 sec. We investigated the consequence between the score of MABC-2 and Gaze fixation rate (FR), Average distance between the center of the object and the gazing point (AD), Longest gaze fixation time (LFT), Number of saccade (NS) and Search time (ST) for objects in each task using multiple regression analysis. In addition, the same contents were compared between three groups.

Results

In Fixation tasks, AD(p<0.05), LFT(p<0.01) were significantly related with the scores of MABC-2. LFT, FR(p<0.05) in Pursuit tasks and FR (p<0.05) in Saccade tasks were significantly related with and MABC-2 scores. In Fixation tasks, FR, LFT(p<0.05) of DCDs were significantly decreased compared to NDs. In Pursuit tasks and Saccade tasks, several FRs, NS and AD (p<0.05) of DCDs to the moving object were significantly different compared to the NDs.

Discussion and conclusion

This study showed that although it is affected by comorbidities such as attention disorder, children with DCD may have several eye movement characteristics, suggesting that this device may be effective for early detection. Children with DCD who have problems with eye movements may improve motor coordination by vision training as early intervention.

Keywords: Saccade, Fixation, Eye movements, Pursuit
Proprioception disorder in children with dyslexia

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**Background and aim**

Proprioception, the ability without vision to localize our limbs (Proske, 2009), is a well-known impaired function in Developmental Coordination Disorder (DCD; Tseng, 2018). However, proprioception is not only a sensorial process but a cognitive one as well. For example, Roll (2008) showed the possibility to evoke illusory writing movements through specific sets of muscle vibrators. Furthermore, there is indirect evidence that Developmental Dyslexia (DD) could be associated to impaired integration of proprioceptive signals in balance control (Quercia et al, 2007). The aim of this study was to specifically compare proprioception in 28 children aged 10 to 12 years with (13) and without DD (15).

**Method**

Importantly, only DD children without comorbidity participated to the study. We used an isokinetic dynamometer to evaluate elbow proprioceptive ability on two different tasks: a speed threshold detection task and a position matching task (Hillier, 2015). Children were blindfolded for both tasks. In the speed threshold detection task, children were asked to report passive motion (0.25°s⁻¹ to 20°s⁻¹; presented in a pseudo-random order) by pressing a trigger – as soon as they felt the motion. In the position matching task, children were asked to report a memorized arm position (20°, 40° & 60° of elbow flexion). Additionally, all children underwent evaluations of their cognitive skills (reading, phonological & word identification) as well as visual and auditory reaction times.

**Results**

We found no differences between DD and TD (typically developing) groups on the mean reaction time (p = 0.92 for visual and p = 0.60 for auditory) nor on their variability (visual, p = 0.73; auditory, p = 0.56). Repeated measure ANOVA yield a significant interaction group x speed for mean (F 4, 104 = 6.93, p < 0.001) and for intra-subject variability (F 4, 104 = 5.90, p < 0.001). Post-hoc analysis revealed that DD children exhibited significantly longer detection times than TD children for the slowest speed (p = 0.001 for 0.25°s⁻¹). DD were also more variable than TD at this speed (p = 0.0005). As described in the literature (Proske, 2012), for both groups, angular errors on the matching task were more important for the largest amplitudes. However, we found no differences between DD and TD groups on the matching task (F 2, 52 = 6.35, p = 0.70).

**Discussion and conclusion**

Our study uncovers impaired proprioception in children with Developmental Dyslexia. Correlation analyses between cognition and proprioception also support this new finding.

*Keywords: proprioception, cognition, dyslexia, sensoriality*
Catechol O-methyltransferase polymorphism affects MABC-2 performance profile

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Background and aim

Genetic components partially determine the risk of movement disorders. However, few studies have investigated the genetic background of developmental coordination disorder (DCD), which is often diagnosed with the Movement Assessment Battery for Children-Second Edition (MABC-2). The present study aimed to determine the associations between MABC-2 performance profile and DCD-associated candidate polymorphism.

Method

Participants were 97 typically developing individuals (mean age = 24.3 ± 4.7 years; male = 41) who completed the test set of the MABC-2 for Age Band 3. As one of the candidate polymorphisms, the catechol O-methyltransferase polymorphism (COMT) rs4680 was determined by polymerase chain reaction-restriction fragment length polymorphism analysis. We examined the patterns of the MABC-2 performance profile using cluster analysis, and then investigated the associations between the profiles and COMT polymorphism (i.e., Val / Met allele).

Results

A cluster analysis identified 3 patterns of the profile: group 1 consisted of participants who performed better on the Manual Dexterity subscale (n = 45); group 2 consisted of participants who performed better on the Balance subscale (n = 27); and group 3 consisted of participants who performed better on the Aiming & Catching (n = 25) subscale. Performance scores on the MABC-2 were significantly different among all 3 groups, confirmed by analysis of variance (P < .05). Moreover, the proportion of participants with Met homozygotes was significantly higher in group 3 compared with the other groups (P < .05).

Discussion and conclusion

Our results indicate that the profile with enhanced ball skills is associated with the Met allele of COMT polymorphism. The Met allele is significantly associated with reduced COMT activity, which leads to increased dopamine levels in the prefrontal cortex. Increased dopamine levels can usually elicit enhanced cognitive abilities related to prefrontal cortex activity in carriers with the Met homozygotes compared with Val allele. Actually, the ball skills tasks of the Aiming & Catching subscale required participants to employ cognitive abilities, such as planning, attention, and shifting, in addition to motor skills. Thus, the COMT polymorphism is associated with DCD, especially the difficulty in the ball skills.

Keywords: Movement Assessment Battery for Children-Second Edition (MABC2), polymorphism, genetic
Validity of the Psychomotor and Executive Function components of the Intelligence and Development Scales for Children and Adolescents (IDS-2)

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Background and aim

The Intelligence and Development Scales for Children and Adolescents (IDS-2) is a broad test battery for individuals aged 5-20 years which has been recently adapted and is currently being standardised for the UK. The IDS-2 includes assessment of Intelligence, Executive Function (EF), Psychomotor skills, Social-Emotional skills and basic skills in Language, Literacy and Numeracy. With any new test it is important to investigate the psychometric properties to evaluate its suitability for use with different populations. The aim of this study is to evaluate (i) concurrent validity and (ii) discriminative validity of the IDS-2 Psychomotor and EF components in children with and without DCD.

Method

24 children with DCD aged 6-9 years, plus 24 typically developing children matched on age and gender will take part in the study. Children with DCD will undergo a full diagnostic assessment to ensure the DSM-5 diagnostic criteria are met. All participants will complete a full IDS-2 assessment. This includes the Psychomotor component comprised of gross motor, fine motor and visuomotor skills and the EF component including divided attention, inhibition, working memory and planning. Participants will also complete the Movement ABC-2 Test and a broad parent/teacher report measure, the Behavior Rating Inventory of Executive Function® (BRIEF® 2) designed to assess nine aspects of EF seen in everyday life: Inhibition, Self-Monitoring, Shifting, Emotional Control, Initiation, Working Memory, Planning/Organization, Task-Monitoring and Organisation of Materials.

Results

Concurrent validity of the IDS-2 Psychomotor and EF sections will be evaluated by examining correlations with scores from the Movement ABC-2 Test and the BRIEF® 2 respectively. Discriminative validity of the IDS-2 Psychomotor and EF components will be evaluated by examining differences between results from the DCD and typically developing group.

Discussion and conclusion

This research will provide psychometric information on the Psychomotor and EF components of the new IDS-2. This information will be useful to clinicians regarding the suitability of these tests for use with children with and without DCD.

Keywords: Assessment, Executive Functions, Motor Skills, Validity
Differences in fine motor performance between first and second trials in children with autism spectrum disorder and attention deficit/hyperactivity disorder

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Background and aim

It is well known that motor impairment is often present in neurodevelopmental disorders such as autism spectrum disorder (ASD) and attention deficit/hyperactivity disorder (AD/HD). However, there are few studies investigating differences and similarities of motor coordination characteristics in children with ASD and AD/HD. The aim of this study was to investigate the differences in fine motor performance between first and second trials in children with ASD and AD/HD.

Method

Thirty children with ASD (27 male, 3 female, mean age 8.9±3.2) and Thirty children with AD/HD (27 male, 3 female, mean age 8.9±2.3) participated in this study. All participants were assessed for fine motor coordination ability using the Manual Dexterity (MD) tests of the Movement Assessment Battery for Children-Second Edition (M-ABC2). We analyzed the difference in seconds that children needed to complete MD1 and MD2 tasks in Trial1 (T1) and Trial 2 (T2) using t-test.

Results

The results showed that there were no significant differences in standard scores of the M-ABC2 MD Total score between children with ASD and AD/HD. In the MD1 task, there was no significant difference in time between T1 and T2 in children with ASD and AD/HD. However, in the MD2 task, children with ASD performed the task in a significantly shorter time in T2 than T1 (p<.05), whereas children with AD/HD had no significant differences in times between T1 and T2.

Discussion and conclusion

Fine motor ability of children with ASD and AD/HD in this study does not significantly differ. However, it was revealed that fine motor function which used both hands improved in children with ASD in T2. This suggests that giving children with ASD more opportunities to complete fine motor tasks is a good way to improve fine motor movement. It should be mentioned that there are differences in praxis and motor learning between ASD and AD/HD individuals.

Keywords: ASD, ADHD, fine motor
Impacts of DCD and AD/HD traits on Handwriting Skills in the Japanese Children with Neurodevelopmental Disorders

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Background and aim

We developed a method of assessing the Japanese character form (kana and kanji) and composition to investigate the impacts of DCD and AD/HD traits on handwriting skills, in the Japanese children.

Method

A method of evaluating the form and composition of the Japanese characters was developed to investigate the effects on handwriting skills of DCD traits, assessed using the Japanese version of the M-ABC2 and DCDQ-J, and AD/HD traits, assessed using the Conners 3 scale, among children diagnosed with autism spectrum disorder (ASD) (n=16), AD/HD (n=3), comorbidity of ASD and AD/HD (n=5), and non-ASD/non-AD/HD (n=5).

Results

The correctness rate in terms of character form and composition was higher for the non-DCD group than for the DCD group. In addition, while a significant positive correlation was found between fine motor control and the correctness rate in terms of character form and composition, no significant correlation was observed with respect to AD/HD characteristics. In addition, correlations with respect to handwriting fluency were observed in scores for the AD/HD characteristics of hyperactivity-impulsivity and inattention.

Discussion and conclusion

This study revealed an association between the traits of neurodevelopmental disorders and handwriting skills, including with regard to the accuracy of the form and composition of kana and kanji characters, the writing system used in Japan.

Keywords: AD/HD, Handwriting, DCD, kana and kanji
Motor development and quality of life in very preterm born children at 11 years of age – PIPARI Study

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Background and aim

Preterm birth is a risk for impaired motor development which in turn have been linked with lower health-related quality of life (HRQoL). Our aim was to study the rates of cerebral palsy (CP) and non-CP motor impairment, developmental coordination disorder (DCD), and evaluate the association between motor development and self-estimated HRQoL in 11-year-old children born very preterm (gestational age below 32 weeks and/or birth weight below 1500g).

Method

A total of 170 very preterm infants born in 2001–2006 were followed up. Diagnosis of CP was determined by 2 years of corrected age. At 11 years of age, the motor outcome was examined by using the Movement Assessment Battery for Children – Second Edition and HRQoL was evaluated by the 17-dimensional illustrated questionnaire.

Results

The majority of very preterm born children performed within the lower range of normal variation considering motor outcome at 11 years of age. The rate of CP decreased and the rate of DCD increased during the six-year period. Very preterm children with DCD presented HRQoL equal to study children without motor impairment.

Discussion and conclusion

Most of the very preterm children born in 2000’s had normal motor development at 11 years of age. Although the rate of CP decreased and DCD increased, DCD did not have significant influence on self-estimated HRQoL.

Keywords: early adolescence, cerebral palsy, long-term follow-up, developmental coordination disorder
Atypical attentional cortical activity during resting in teenagers with Developmental Coordination Disorder (DCD): A pilot EEG study

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Background and aim

Even if DCD is characterized by deficits in motor skills well-established at clinical and scientific levels, these children also present cognitive difficulties. In particular, the literature suggests that attentional processes could be altered in DCD children. However, all studies interested in attention in DCD use paradigms inducing motor responses, which limits possibility to explore attention independently of motor control. In order to investigate the possible attentional deficits in DCD children, we propose to record cortical activity related to attentional processes during a resting task. The present study aims to investigate attentional cortical activity during resting in teenagers with DCD.

Method

Firstly, attentional and motor levels were evaluated, with the CPT II and M-ABC tests respectively. Secondly, ElectroEncephaloGraphic (EEG) data were recorded in 6 typically-developing (TD) children and 10 DCD children during one minute of resting with eyes open (EO) and one minute of resting with eyes closed (EC). Spectral Power of the EEG oscillations were computed in the low and high alpha band (8-10 Hz and 10-12 Hz, respectively) over the parietal cortex in order to reflect the diffuse and focused attentional processes, respectively. ANOVAs Group (DCD vs TD) x Condition (EO vs EC) were carried out on low and high alpha spectral powers. Correlations between levels of low and high alpha EEG power and (1) CPT II and (2) M-ABC scores were computed. The p value was fixed at 0.05.

Results

A significant Group x Condition revealed that high alpha spectral power was lower in EO compared to EC, but less in DCD teenagers. No difference was found for the low alpha band. No correlation was significant.

Discussion. DCD children present specific atypical attentional cortical activity at rest. Focused attention (10-12 Hz) seems to be more altered than diffuse attention (8-10 Hz).

Discussion and conclusion

Even if these preliminary results have to be confirmed with a larger sample size, they encourage us to explore more precisely the resting attentional cortical network in DCD. In particular, the link between the atypical resting brain activity of teenagers with DCD and their behavioral attentional or motor levels remain to be investigated further.

Keywords: parietal cortex, alpha oscillations, focused attention, spectral power
Working with adults with Developmental Coordination Disorder (DCD) in an appreciative way

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Background and aim

Phenomenological research has identified that adults consistently draw on a range of personal factors to help mitigate the disabling impact of living with DCD (Scott-Roberts and Purcell, 2017). However, when they require support they are typically referred to public services, where there is an assumption that professionals will have the answers. In addition, traditional interventions pay little attention to the fact that many individuals demonstrate the ability to self-assess their own skill level, analyse the demands of the environment and the activity, in order to make adaptations that have allowed them to successfully participate, until the point of referral (Scott-Roberts and Purcell, 2017). With this in mind there appears to be a need to move away from traditional ways of working that solve problems for people to using appreciative approaches to ensure practitioners harness this groups’ capacity to self-manage their DCD. To illustrate how Appreciative Inquiry (AI) shaped the co-design of a set of authentic resources with a group of adults, with DCD.

Method

In this project an appreciative approach to intervention, based upon the principles of AI, was used to support a group of nine adults previously diagnosed by a multidisciplinary team with DCD (mean age 32 years; 1:3 Male to female), to share their tried and tested adaptations and strategies to manage every day activities and to design a set of authentic resources to share with others with DCD.

Results

An appreciative approach to management sees ‘inquiry’ as the intervention (Ludema et al 2001) and as such the participants through inquiry were afforded the time to stop, recognise and reconnect with past tried and tested solutions before sharing these with others. Participants were able to celebrate their successes as well as produce a set of ‘Guides to Success’, which have been disseminated worldwide.

Discussion and conclusion

In changing the conversations with individuals we can support them to appreciate their strengths and reconnect or design new ways of working. In doing so we ensure that we support the service user to continue to manage the challenges they face. As a secondary consequence, by offering an appreciative ear, practitioners are afforded the privilege of sharing in the lives of this particular client group, which will continue to further our understandings of the lifelong presentation of this disorder.

Keywords: Appreciative Inquiry, co-design, adults, Intervention
Occupational Therapists’ Service Delivery for Children and Adolescents with Developmental Coordination Disorder in Austria – a Survey

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Background and aim

Developmental Coordination Disorder (DCD) has a major impact on activity and participation of children and adolescents and is one of the most frequent reasons for referral to occupational therapy. The aim of this study was to ascertain how children and adolescents with DCD are treated in occupational therapy in Austria.

Method

An online-survey was distributed via work groups and regional groups of Ergotherapie Austria, the professional association of occupational therapists in Austria. The survey included questions about all stages of the therapeutic process. Additionally we inquired the awareness of the DCD guideline published in 2011. Descriptive data analysis using SPSS was used.

Results

63 occupational therapists completed the whole survey, and additional 31 answered some parts. 70% of the therapists work in private practices, 25% in outpatient clinics, and only 8% at kindergarten or school. Most of the children and adolescents are referred to therapy with ICD-10 diagnosis and receive 10 to 30 sessions. 93% of the therapists deliver individual therapy sessions. 84% of the therapists use standardised assessments to evaluate motor function (e.g. M-ABC-2), and 34% to evaluate activities of daily living (mainly the Canadian Occupational Performance Measure). 72% involve parents and the child/adolescent to set the goals for therapy. Intervention time is relatively evenly distributed between task-specific training, remediation of gross motor, fine motor and perception skills. Only 46% of the therapists select the recommended task-specific approaches. 40% of the therapists have read the DCD guideline or at least part of it, whereas 41% are not aware that there is a guideline.

Discussion and conclusion

Assessments and goal setting for children with DCD broadly correspond to the DCD guideline. Task-specific approaches, as recommended in the DCD guideline, are implemented; however, bottom-up approaches are widely used in Austria. There is a great need to raise the awareness of the guideline. Different strategies of knowledge translation will be required to inform therapists about the upcoming new DCD guideline which will be published at the end of 2018.

Keywords: occupational therapy, children and adolescents, service delivery, awareness of DCD guideline
Background and aim

This study aimed to describe the translation and transcultural adaptation of the Little DCDQ for 3-4-years-old Brazilian children, to conduct preliminary item analysis to identify strengths, limitations and define further validation steps.

Method

Translation of the questionnaire to Portuguese was conducted in two steps, first, three translations and two back-translations of the questionnaire were obtained; second an expert panel with 17 rehabilitation professionals and 10 parents of children aged 3-4 years evaluated to translation for clarity. The questionnaire was then tested on a target sample of children with and without risk for DCD. Parents of 59 children from two different regions in Brazil (Paraná and Minas Gerais), 34 with typical development (TD-group) and 25 with risk factors for motor problems, such as prematurity (Watch and see /WS-group), responded the L-DCDQ-Brazil and a family/child characteristics’ questionnaire. Convenient sampling was conducted among colleagues, occupational therapy private practice and a follow up program for preterm infants. Groups were compared and the L-DCDQ-Brazil was submitted to Rasch analysis.

Results

The TD-Group, with 17 (50%) males, had mean gestational age at birth of 38.54 ±1.53. The WS-group had 14 males (55%), mean gestational age 34.71 ±4.69. Besides gestational age, groups did not differ in other variables, including testing age. There was no gender difference on L-DCDQ-Brazil’ total score (p=.67), neither between 3 and 4 year olds (p=.90). Internal consistency (Cronbach Alpha) was .907, varying from .898-.913 if any one item deleted. WS-Group scored lower (Mann Whitney U >.05) on all items, total score and subareas, except for items 2 (Catch large balls two hands), 3 (Kick rolling ball), 9 (Posting coins) 13 (Use playground equipment), in which groups did not differ. Rasch analysis indicated good reliability for item calibration (.80) and children’s measures (.89), with items dividing the children in 3 ability levels. Four children scored maximum and only item 15 (Seat straight) misfited the Rasch model, which suggests unidimensionality. Principal component analysis indicated two possible dimensions, but factors were not theoretically and clinically meaningful; there was no evidence of local dependency. Overall, items were easy for the sample, with the WS-group scoring on the lower end of the motor ability continuum.

Discussion and conclusion

The L-DCDQ-Brazil showed good measurement properties, it has potential to differentiate motor ability, but not age. A few items should be rechecked for meaning, before further validation procedures in the Brazilian context.

Keywords: Validity, Developmental Coordination Disorder, Rasch Analysis, Cultural Adaptation
Assessing the Executive Functioning Profiles of Adults with and without Developmental Coordination Disorder using an Ecologically Valid Measure

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Background and aim

Executive functioning has been related to motor skills and coordination, and reciprocally, many individuals diagnosed with neurodevelopmental disorders who have executive functioning difficulties also report poor motor coordination. However, the executive functioning profile of adults with Developmental Coordination Disorder (DCD) have not yet been investigated using measures other than standardised tests and self-report (Tal-Saban, Ornoy & Parush, 2014). The present study therefore sought to examine the executive functioning profile of individuals with DCD in adulthood using an ecologically valid measure.

Method

In an adult sample of 17 participants with possible DCD, and a typically developing (TD) sample of 20 participants, the Jansari assessment of Executive Functions (JEF©) was conducted to provide measures of planning, prioritisation, selective thinking, creative thinking, adaptive thinking, and action-, event- and time-based prospective memory, as well as an overall task average. Individuals were identified as either control or probable-DCD participants using the Adult Developmental Coordination Disorder Checklist and the Movement ABC-2 test scores.

Results

Differences were observed between TD and DCD participants in terms of planning and action-based prospective memory, with individuals in the probable-DCD group displaying lower accuracy than the TD controls. Additionally, a Z-score comparison analysis was conducted between nine participants identified as having probable-DCD, and the typically developing group. This analysis revealed a pattern of difficulties in planning and prospective memory, but also highlighted adaptiveness and creativity as an area of strength.

Discussion and conclusion

Adults with DCD had significant difficulties planning their work and responding to cues to disengage from current activities to complete secondary tasks. Averaged task performance across all JEF© measures indicated poorer overall performance in the DCD group. Implications for workplace support and strategies will be discussed.

Keywords: ecological validity, real world tasks, adults, executive functions
DCD and participation at school. The utility of the School Assessment of Motor and Process Skills (School AMPS) and the Evaluation of Social Interaction (ESI) at school.

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Background and aim
A big part of children’s daily life takes place at school, in the classroom as well as at the playground. We know that a lot of children with DCD experience problems in participating in school. Aim of our study is to study utility of the School Assessment of Motor and Process Skills (School-AMPS) and the Evaluation of Social Interaction (ESI) to improve treatment of children with Developmental Coordination Disorder (DCD).

Method
The School AMPS and the ESI are both valid and standardized observations which help you to see how the child acts in it’s own environment.

We describe some case studies to illustrate utility of both instruments for intervention of children with DCD.

Results
The case studies illustrate usefulness of the School AMPS and ESI. They give insight in daily life functioning and participation of the children with DCD in their own natural environment. Interaction problems with physical and social environment became clear where this stayed unclear in the more standardized and one-to-one therapy situation. Since implementation of the School AMPS and ESI in our treatment program, treatment period has been reduced with 8 weeks.

Discussion and conclusion
Using the School AMPS and the ESI seems very useful in treatment for children with DCD. It helps the child, it’s parents and teacher and the whole team at the rehab center to get a better understanding of the problems the child is facing in daily life. This helps all to adapt their interventions in order to help the child to participate better at school.

Keywords: School-AMPS ESI participation environment
Developmental Coordination Disorder (DCD): retrospective analysis of risk factors in patients with late diagnosis

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Background and aim

The early identification of DCD is essential for the well-being of children and their families. The recognition of any difficulties leads to a reduction in the risk of behavioral disorders or consequential developmental disorders. According to the European Guidelines it is possible to diagnose DCD from 5 years of age.

Making a clear distinction among (1) surveillance (recognition process of children who may be at risk of developmental delay), (2) screening, (use of standardized tools to identify and quantify risk) and (3) evaluation (aims to identify specific developmental disorders), plays a role of great importance.

The scholastic environment is the first non-family area where children challenge their skills independently. Teachers should perform a first filtering action in identifying any educational, behavioral and social difficulties (surveillance), to which the child neuropsychiatrist will eventually have to attribute a symptomatological value (evaluation). Another important figure in monitoring the health of pre-school children is the basic pediatrician (screening).

The present work aims to analyze the type and age of onset of possible early symptoms of DCD through questionnaires and retrospective interviews.

Method

30 children (8-14 years old) participate in the study. They present difficulties in school-work (learning, adaptation and emotional). Their neurological and neuropsychological abilities are assessed (WISC-IV, CORSI test, Rey’s complex figure, TOL). Furthermore, DCD-Q, M-ABC-2 and M-ABC-2 Checklist are performed.

In order to define the early symptoms retrospectively, the neuropsychological and logopaedic history and the Developmental Profile – Third Edition (DP-3) are performed.

Results

Preliminary analysis of data reveals difficulties in coordination and adaptive behavior, but also in the area of linguistic development.

Discussion and conclusion

The identification and quantification of early symptoms allows the planning of screening activities both in school (targeted projects) and through the basic pediatrician (observation and questionnaires) for an earlier delivery of assessment, diagnosis and specialist rehabilitation. Final analysis results will be presented.

Keywords: linguistic diseases, screening activities, early symptoms
Effect of comorbid reading disorder on oculomotor behavior in children with DCD

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Background and aim

Studies have suggested a dysfunction in oculomotor skills in children with developmental coordination disorder (DCD; Robert et al., 2014; Sumner et al., 2016). The Developmental Eye Movement (DEM) test (Garzia, et al., 1990) has been showed to be useful in exploring the oculomotor behavior of dyslexic children (DD; Moiroud et al., 2018). This standardized test comprises horizontal and vertical digit reading tasks and provides reading time and errors norms as well as oculomotor type of response. This study aimed at exploring oculomotor behavior in children with DCD as assessed with DEM test. Furthermore, we compared children with DCD to children with DD and with children with both DCD and DD to investigate the effect of comorbidity on DCD’s oculomotor skills.

Method

The study included 22 DCD children, 47 DD children, 27 children with DCD+DD, 42 typically developing children (TD). Children were aged between 8 and 12 years (DYSTAC-MAP French cohort). Z-scores were computed for each child’s DEM score: vertical time, horizontal time, ratio between horizontal and vertical time, and number of errors. Children’s response types were obtained from those scores. Groups were compared by using non-parametric statistics.

Results

Kruskall-Wallis test showed a significant effect of group for all z-scores, with TD performing the best and DCD+DD the lowest. Pairwise comparisons demonstrated that children with isolated DCD differed from TD children only for the error z-scores (p<.008). In contrast, children with DD and DCD+DD had lower z-scores than TD children for the horizontal time, vertical time and in the error z-scores (p<.0001). Differences between DCD, DD and DCD+DD groups were not significant. Finally, children with DCD, as did DD and DCD+DD children, were more often presenting abnormal oculomotor response type than TD children.

Discussion and conclusion

The results confirm that children with DCD present atypical oculomotor behavior at the DEM test (Robert et al., 2014; Sumner et al., 2016). However, reading disorder was more clearly linked to the scores of the test (Moiroud et al., 2018). In conclusion, research focusing on low-level oculomotor skills in DCD should comprise a reading test to exclude the effect of comorbid DD on visual behavior. More research is needed to explore the nature of oculomotor disorder in DCD children and distinguish DD and DCD oculomotor behavior.

Keywords: DEM test, dyslexia, DCD, comorbidity
DCD: retrospective analysis of risk factors in patients with late diagnosis

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Background and aim

The early identification of DCD is essential for the well-being of children and their families. The recognition of any difficulties leads to a reduction in the risk of behavioral disorders or consequential developmental disorders. According to the European Guidelines it is possible to diagnose DCD from 5 years of age.

Making a clear distinctions among (1) surveillance (recognition process of children who may be at risk of developmental delay), (2) screening, (use of standardized tools to identify and quantify risk) and (3) evaluation, (aims to identify specific developmental disorders) play a role of great importance.

School situations are the first non-family area where children challenge their skills independently. Teachers should perform a first filtering action in identifying any educational, behavioral and social difficulties (surveillance), to which the child neuropsychiatrist will eventually have to attribute a symptomatological value (evaluation). Another important figure in monitoring the health of pre-school children is basic pediatrician (screening).

The aim of the work is to analyze the type and age of onset of possible early symptoms of DCD through questionnaires and retrospective interviews.

Method

The children (30 subjects) were recruited in private medical practice facilities. They have an age at the time of diagnosis between 8 and 14 years. The incoming was motivated by difficulties in school-work (learning, adaptation and emotional). Each subject underwent a neurological and neuropsychological examination (WISC-IV, VMI, CORSI test, Rey’s complex figure, Mazes, TOL). Furthermore, DCD-Q, M-ABC-2 and M-ABC-2 Checklist were administered. All subjects show difficulty in motor coordination and a total M-ABC-2 score.

In order to define the early symptoms retrospectively, the neuropsychological and logopedic history and the Developmental Profile – Third Edition (DP-3) were performed.

Results

Preliminary analysis of data reveals difficulties in coordination and adaptive behavior, but also in the area of linguistic development.

Discussion and conclusion

The identification and quantification of early symptoms allows the planning of screening activities both in school (targeted projects) and through the basic pediatrician (observation and questionnaires) for an earlier delivery to assessment, diagnosis and specialist rehabilitation.

Keywords: longitudinal analysis, Cornelia de Lange Syndrome
Sensory and cognitive correlates with motor coordination in 5-years old children with developmental disorders including DCD, ASD and ADHD

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Background and aim
This cross-sectional research aimed to examine sensory and cognitive correlates with motor coordination in 5-year-old children.

Method
Of the 1,997 children who were screened at the Five-Year-Old Health Check-up in Hirosaki City in Japan in 2016 and 2017, 175 children (110 boys, 65 girls) participated in this study. The 175 participants consisted of 76 children with DCD and 99 children without DCD (n = 99). Of the children with DCD, 52 children had only DCD, 6 children had DCD and ASD, 14 had DCD and ADHD, and 4 had DCD, ASD, and ADHD. Of the children with DCD, 69 had no developmental disorder, and 30 children had either ASD and/or ADHD. We administered the Movement Assessment Battery for Children, 2nd Edition (MABC-2), the Wechsler Intelligence Scale for Children, 4th edition (WISC-IV), and the Japanese Version of Miller Assessment for Preschoolers Short version (S-JMAP) to the 175 participants. A stepwise multiple regression analysis was conducted to identify sensory and cognitive variables that best predict motor coordination.

Results
The strongest correlation was observed between the threading beads item of the MABC-2 with the sentence repetition item of the S-JMAP (r = .33, p < .01) and with the coding subtest of the WISC-IV (r = .33, p < .01).

Discussion and conclusion
This study showed the sensory and cognitive correlates with particular motor coordination skills. The results suggest possible sensory and cognitive involvement in the motor skills.

Keywords: sensory, MABC-2, motor coordination, cognitive function
Motor Response Inhibition during the Stop Signal Task in Adults with Developmental Coordination Disorder

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Background and aim

Developmental Coordination Disorder (DCD) is a neurodevelopmental disorder characterised by motor learning and executive functioning difficulties. Inhibitory control is a core executive function required for efficient goal directed behaviour, and may be related to motor learning. Studies in children with DCD report differing inhibitory control deficits depending on task type (Leonard & Hill, 2015). However, few studies have investigated whether inhibition difficulties persist into adulthood in DCD.

Method

The present study used a Choice Reaction Task (CRT) and Stop Signal Task (SST) paradigm to gain a measure of inhibition that takes into account processing speed. Initial reaction speeds were measured using the CRT and an SSRT taking into account these reaction speeds was produced by the SST. The SST also monitored response speeds for significant slowing behaviour; if slowing was detected between trials then negative feedback was displayed instructing the participants not to slow their responses. Background measures to determine fulfilment of DCD diagnostic criteria included the MABC-2, ADC, WASI-II and CAARS:S-L. 11 DCD and 30 typically developed (TD) adults (median-split between 15 high-motor and 15 low-motor skilled participants) participated in this study. None of the DCD participants reported a comorbid diagnosis.

Results

No significant group differences were found in terms of IQ or ADHD symptoms. A result approaching significance (F(2, 38) = 2.76, p = .08) indicated that individuals with DCD had a slower median response time during the CRT, which was not observed during the SST, possibly reflecting the more cautious approach TD adults adopted during this task. Contrary to previous studies, no significant differences were found between DCD adults in terms of motor inhibition speed or accuracy when compared to typically developing adults of high and low motor skill. No evidence was found for the adoption of a strategic slowdown favouring accuracy over speed in the DCD group.

Discussion and conclusion

Individuals with DCD did not differ significantly in SST performance from high and low-motor skilled controls. The DCD, HM and LM groups did not differ in the amount of negative feedback received, suggesting that the groups adopted similar strategies when performing the SST. These initial findings in a small sample of adults with DCD indicate a possible improvement with age in terms of inhibitory control.

Keywords: inhibition, adults, executive functions
Translation and validation of a Revised Arabic Version of the Developmental Coordination Disorder Questionnaire (DCDQ'07)

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Background and aim

Developmental Coordination Disorder (DCD) is a neurodevelopmental syndrome resulting in a significant impairment of the acquisition and performance of coordinated motor skills. This condition affects activities of daily living or academic learning, not explained by intellectual disability, visual impairment or neurological condition. Estimates of prevalence range from 2 to 7%.

DCD is frequently misunderstood and confused with several other disorders. Therefore, early identification and treatment of DCD is crucial to mitigate its socio-educational and health consequences. In addition, there are few or no valid Arabic assessment tools. This study proposes to perform a transcultural adaptation of the English DCDQ'07 in Arabic, and to examine its psychometric properties among a Lebanese population.

Method

The research team performed translation of the DCDQ into Arabic according to current guidelines for cross-cultural adaptation of instruments. We first performed a translation into Arabic, followed by a back translation, then by an expert committee review, and finally by pre-testing with a group of 38 parents. Two items were adapted using the decentering design in keeping with local culture. In the validation phase, a total of 180 parents completed the DCDQ-LB and their children (mean age = 9.45; SD = 2.75; min–max=5–15) passed the Movement Assessment Battery (M-ABC 2), 34 of the parents repeated the questionnaire after 2 weeks for test–retest reliability. Statistical analyses for reliability and validity were applied to analyze the psychometric qualities of the translation.

Results

The DCDQ-LB has excellent internal consistency (Cronbach Alpha = 0.9) and excellent test-retest reliability (ICC = 0.9). Differences in scores between children with and without motor difficulties (U=919; p < .001) provide clear evidence of construct validity. Correlations between the DCDQ-LB scores and Movement Assessment Battery for Children (r = .65) show an adequate concurrent validity. Sensitivity (87.7%) and Specificity (88.6%) scores of this questionnaire also showed a very good level, considering the cut-off scores for the 16th percentile of M-ABC 2.

Discussion and conclusion

Translation into Arabic was successful, the DCDQ-LB proved a valid tool to specifically assess DCD in an Arabic-speaking population.

Keywords: Arabic parent’s questionnaire, screening tools, Developmental Coordination Disorder, cross-cultural validation
Brain MRI and concurrent motor development in very preterm born children at 12 years of age – LOVIS Study

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Background and aim

Very preterm infants are susceptible to brain injury and have an increased risk for adverse long-term motor development. Our aim was to describe the brain magnetic resonance imaging (MRI) findings and concurrent motor outcome in very preterm born children at 12 years of age.

Method

Very preterm infants (gestational age <32 weeks) born in 2004-2007 were followed up. Brain MRI and the Movement Assessment Battery for Children – Second Edition (The Movement ABC-2) and were performed at 12 years of age. In addition, the parents filled out the Developmental Coordination Disorder Questionnaire 2007 (DCDQ’07). Developmental coordination disorder (DCD) was determined by using the cut-off of 5th percentile or less in the Movement ABC-2 in combination with a total score between 15-57 on the DCCQ’07.

Results

The majority of very preterm born children had normal findings in brain MRI at 12 years of age. Most of the children performed within the lower range of normal variation considering motor outcome at 12 years of age. Very preterm children with DCD presented more brain pathologies than study children without motor impairment.

Discussion and conclusion

Although most of children had normal findings in brain MRI and motor examinations, there was an increased rate of DCD in very preterm born children at 12 years of age. Therefore, it is crucial to perform structured motor assessments in the clinical follow-up of very preterm born children to detect DCD that can have significant negative influence on children’s everyday life.

Keywords: developmental coordination disorder questionnaire, long-term follow-up, brain imaging, developmental coordination disorder
Multidisciplinary assessment as a key opportunity to identify comorbidities in children with developmental co-ordination disorder (DCD)

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Background and aim

To establish rates of physical, emotional and developmental co-morbidity in children presenting for multidisciplinary DCD assessment.

Method

A retrospective electronic case notes analysis of 50 children that attended our joint paediatric and occupational therapy DCD assessment clinic from October 2015 to July 2018.

Results

Complete data was obtained for 44/50 patients. 26/44 (59%) children were given a diagnosis of DCD. In 19 (73%) of these children we identified important additional physical health needs. Obesity and poor core strength were the most common comorbidities seen in children with DCD; both seen in 7/26 (27%) patients. Other comorbidities were hypermobility [2/26, (8%)] and medical needs such as dental and dermatological abnormalities. [2/26 (8%)].

14/26 (54%) children diagnosed with DCD also had social, emotional or mental health needs e.g. low mood and poor self-esteem, challenging behaviour or sleep difficulties. 12/26 (46%) children with DCD presented with attention difficulties. 6 children with DCD (23 %) had a confirmed diagnosis of ADHD/ADD.

10/26 (38 %) children with DCD were considered to have additional learning needs and 5/26 (19%) presented with social communication difficulties.

The commonest patterns of poly-morbidity were DCD plus social, emotional or mental and medical needs (n=11, 42%) and DCD plus attention and medical needs (n=10, 38%).

Discussion and conclusion

This is a small audit however, it identifies that DCD is rarely a discrete disorder and that physical, developmental and emotional co-morbidity rates are high. Multidisciplinary DCD assessment is a unique opportunity to conduct a holistic assessment of child’s developmental, physical and emotional health needs. Where comorbidities are identified action can be taken to help reduce further impact on quality of life.

Keywords: comorbidities, DCD assessment, multidisciplinary
Using the free writing task of DASH in the evaluation of handwriting, orthographic and writing competences of Italian children

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Background and aim

Compositional quality in writing can improve if handwriting and orthographical skills are well learnt and automatized. Each one of these abilities takes time to be refined. Van Galen’s (1991) psychomotor model can offer a useful lens for considering handwriting skill by evaluating selection of the allographs, programs for their size, speed, and spacing and recruitment of muscle synergies, which results in the real-time movement of the pen. The model also considers the complex integration of cognitive (activation of the intention to write), linguistic (semantic retrieval and syntactical construction) and motor processes that underpin the task (Van Galen, 1991). Following Van Galen’s model, the present study aims to verify the interactions among graphic-motor, orthographical and compositional ability along a school period in which free writing represents a crucial task. Within the Italian school system, this period approximately begins when children are 9 (corresponding to the 4th grade of Italian primary school, after the formal teaching of handwriting and orthographic abilities). Besides, the use of a single task to collect several measures about writing skill was pursued.

Method

A convenient sample of 154 students (81 males and 73 females), 9 to 14 years old, were involved in the study. The free writing task about the topic "my life", drawn from the Detailed Assessment of Speed in Handwriting (DASH) Test (Barnett et al., 2007), was collected and handwriting speed was evaluated as in the original task. We also evaluated the text according to parameters that address handwriting quality, orthographical and compositional ability. We selected the measures from national tests, which assess speed, legibility, orthographic and compositional ability (DGM-P, Borean et al., 2012; BVSCO-2 Test, RE et al., 2013).

Results

Considering handwriting speed, a developmental trend in our Italian children sample was found, with a progressive increase in the number of words per minute from 9 to 14 years-old (B=2.05; p<0.01). In the whole sample we also found significant correlations (p<0.01) between handwriting speed (number of words per minute) and syntactical quality of the text (number of morphosyntactic errors: r=-.369; number of punctuation errors: r=-.286) as well as the number of clauses in the text (r=.852). Similar correlations were found between orthographic errors and morphosyntactic as well as punctuation errors.

Discussion and conclusion

These initial data revealed the applicability of DASH free writing task for the evaluation of writing in school aged Italian children and pointed out its usefulness in examining different aspects of writing abilities.

Keywords: writing, speed, handwriting
Cognitive Orientation to Daily Occupational Performance with children with Developmental Coordination Disorder: What do parents think?

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Background and aim

To investigate the perception of parents/caregivers about the process and effects of the CO-OP approach with children with Developmental Coordination Disorder (DCD). Children with DCD have motor difficulties that limit participation in environments such as home and school. There is growing evidence that Cognitive Orientation to Daily Occupational Performance (CO-OP) Approach is effective in the treatment of children with DCD, but since CO-OP differs from traditional approaches, it is important to consider the lived experience of Brazilian parents/caregivers with this collaborative intervention.

Method

Descriptive qualitative study with 22 parents/caregivers of 14 children ages 7 to 10 years-old with DCD who participated in occupational therapy using CO-OP. This study is a subproject of a randomized controlled trial (RCT) on the effects of CO-OP with (experimental-group) and without (control-group) parental coaching. Parents/caregivers in the control group participated in CO-OP sessions, while in the experimental group there was addition of coaching sessions. Data was gathered by focal groups, with five to seven parents/caregivers each, that were translated verbatim and submitted to thematic analysis.

Results

Thematic analysis revealed common themes regarding what draws parents'/caregivers' attention about the CO-OP, the outcomes that go beyond the achievement of intervention goals for both children and parents/caregivers, the challenges of participating in CO-OP and the desire for continuation. One theme was identified exclusively on the experimental group, who viewed the coaching sessions as a relief space to share experiences.

Discussion and conclusion

The intervention with CO-OP generated changes not only in children, but also in the parents/caregivers. Although the lack of time to be with the children during the therapy sessions was identified as a challenge, with active participation in the therapy parents/caregivers learned how to deal with the child’s difficulties and to assume a more supporting role to the child’s learning, optimizing the results of therapy. As they perceived the results of the therapy, children became more independent in daily activities and persistent when facing new challenges. Parents/caregivers reported they expect the child and themselves to continue using what they have learnt. This study, based on parents/caregivers narratives, adds evidence to the utility of the CO-OP approach to improve occupational performance of children with DCD. Understanding the experience with the intervention contributes to the therapist’s clinical reasoning and facilitates the delivery of more meaningful interventions. A model of the change process, for both parents and children, with therapy will be proposed.

Keywords: Cognitive Orientation to Daily Occupational Performance (CO-OP), Occupational Therapy, Parent, Qualitative Research
Simultaneously delivering clinic- and home-based programs for children with developmental coordination disorder (DCD): A multiple case study

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Background and aim

To describe how a simultaneous delivery of clinic- and home-based programs for children with DCD work and to gain insights into the feasibility, usefulness, and problems with the simultaneous delivery.

Method

Four children with probable DCD, who were referred to a teaching and research laboratory (Movement Development Clinic), and their families participated in this study. Over a 10-week period the four children attended 7 weekly 50-minute clinic sessions and four pairs of student teachers, with each pair assigned to a child, worked on tasks that were meaningful to the children and families. The Family Focused Intervention for DCD was used as a framework for a home-based program and introduced to the parents in the second week; the families were encouraged to fill in the workbook, seek resources, and practice target skills at home. The children and parents reported the fidelity of their home practice when they came to the clinic. The parents also communicated with the home-based program coordinator (MC) by email during a total of 3-week clinic breaks. Endpoint assessment was carried out with the Movement Assessment Battery for Children, Second Edition in the last clinic sessions.

Results

The children practiced skills, such as bicycle-riding, tying shoelaces, swinging across the monkey bar, handstand, cartwheel, passing and catching soccer and rugby balls, and handwriting at the clinic and home. Not all of them were able to fully acquire the skills at the levels that they initially hoped. However, they all progressed towards the long-term objectives to a different degree. Endpoint assessment indicated that all four children fell within the cutoff range of probable DCD. Two of the four families effusively participated in the Family Focused Intervention and the other two families reported difficulties with home practice due to a lack of time, resources, confidence, and motivation.

Discussion and conclusion

While all four children responded well to the individual clinic treatment programs, the family involvement and participation in the home-based program varied. The significance of this multiple case study lies in the increased awareness of diverse family needs and capacities to support children with DCD at home; the feasibility of home program depends on the family situation and context.

Keywords: case study, feasibility study, clinic-based intervention, home-based intervention
The "Movement Coach on the Move": an, in-school, interventional management program for students with motor learning difficulties

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Background and aim

The purpose of this presentation is to exhibit quantitative and qualitative data and results from an, in-school, interventional management program for students with motor learning difficulties which is being implemented since 2011 by the Physical Education Department at the Doukas Elementary School, Athens, Greece. The program is titled "on the Move" and the key factor and goal was the idea of the "Movement Coach" and the guidelines of the "Ecological Approach" proposed by Henderson and Sugden (2007).

Method

The program includes six stages: 1. A Fall education stage, during which, the educators are trained in screening and identification techniques to be able to spot the children who may face motor coordination difficulties; 2. An actual identification stage where all the suggested, by their educators, children are screened though the use of a Checklist; 3. A motor assessment stage where the children who had been identified to motor assessment; 4. A Winter education stage, during which P.E. teachers are informed regarding the preliminary results of the motor assessment. In parallel they are (re)trained to serve as Movement Coaches; 5. A report stage, where Movement Coaches organize cross-disciplinary meetings where the parents are informed regarding the results of the process and they take part in the planning of the intervention strategy and 6. An annual and/or biennial stage of re-assessment and adaptation of interventional management plans.

Results

Since 2011: 211 students were carefully observed, 112 of them were referred for further motor assessment; 52 students underwent motor assessment and 32 of them were reassessed at least once; Intervventional management was designed and implemented for 35 students; more than 73 educators participated to all or to specific stages of the program; more than 110 Meetings with the Parents, P.E. Teachers/Movement Coaches and School Psychologists have been employed. Finally, at least four P.E. Teachers have been acting as Movement Coaches. Annual re-assessments have been shown that at least half of the students have been significantly improved not only regarding in-school motor behavior but, also regarding their daily motor activity.

Discussion and conclusion

The program has led in a general change in the school culture, putting diversity as the dominant educational factor, regardless of the school object. Several major delimitations will also be discussed. The program is currently under a thorough assessment process mainly through questionnaires and interviews in parents and educators. Quantitative as well as qualitative results will be presented and discussed.

Keywords: In-school intervention, Movement Coach, Physical Education
Reliability and validity of the Developmental Coordination Disorder Questionnaire – Brazilian version (DCDQ-Brazil) – Rasch analysis

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Background and aim

To conduct detailed item analysis of the DCDQ-Brazil using Rasch analysis to investigate the questionnaire’s reliability and validity for Brazilian children ages 5-10-years-old.

Method

Data was combined from four different studies. Children ages 5 to 10 years old were recruited in public and private schools in a major city in Brazil (Belo Horizonte). Children of both genders, with no signs of motor, visual, hearing and/or cognitive disorder, whose parents had concluded primary and middle school, were included. Glasses for visual correction were allowed, but not hearing aids. Children with history of school failure/grade repetition were excluded. Parents completed the DCDQ-Brazil and demographic questionnaire. Children were assessed with the Movement Assessment Battery for Children, 2nd ed (MABC-2) and, to exclude cognitive deficits, the Columbia Mental Health Maturity Scale or the Raven’s Colored Progressive Matrices were utilized.

Results

The participants were 726 children, 341 (47%) males, mean age 94.18 ±22.62 months. All children had cognitive measure within normal range, and 50 (6.9%) were identified as possible-DCD on the basis of the MABC-2 < 15th percentile and DCDQ-Brazil score below the cut off point. There was no gender difference on DCDQ-Brazil’ total score (p=.33), but there was age difference (p=001), with older children getting higher scores. Internal consistency (Cronbach Alpha) was .868, varying from .853-.875 if any one item deleted. Rasch analysis indicated poor reliability for children’s measures (.77) and excellent reliability for item calibration (.89). Items divided the children in 2 ability levels and items were divided into 10 ability levels. Twelve (1.7%) children scored maximum, 26 children (3.6%) and two items (13.3%) – 14 (Competent tidying up) and 15 (Seat straight) – misfitted the Rasch model, presenting unpredictable patterns of response, which suggests unidimensionality. Principal component analysis, however, did not identify a second interpretable dimension. There was no evidence of local dependency. Overall, items were very easy for the sample, but children with probable-DCD scored on the lower end of the motor ability continuum. Sensibility and specificity to detect DCD will be calculated.

Discussion and conclusion

DCDQ-Brazil’s external consistency was good, but reliability of the children’s calibration was below expectation, probably because items were too easy for the children. Two items presented unexpected response, which also contributes to poor reliability. This may not compromise the potential of the DCDQ-Brazil as a screening tool, but the possibility of adding more difficult items should be considered, especially for older children.

Keywords: Developmental Coordination Disorder; Questionnaire; Validity, Rasch Analysis
Sports-specific gross motor assessment: developmental profile of skills in young, beginner netball players

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Background and aim

The aim of this study was to investigate the profile of gross motor skill acquisition in young, beginner netball players aged eight to twelve years. Children with DCD demonstrate motor skills substantially below expectations for age and opportunity. In sport, this can manifest as slowness and inaccuracy of motor skills, difficulty with learning and developing new sport-specific skills, and self-esteem issues. Netball is a highly popular winter sport in many countries. From beginner grades, it demands proficient skills in running, jumping, dodging, catching, throwing and shooting. Skills must evolve as the game becomes faster and more demanding with age. Coaches and therapists often need to support girls with motor coordination difficulties to learn and improve skills for netball. However, at this stage there is no age-related skills profile to guide assessment.

Method

Game skills analysis was performed for 112 players aged 8-9 years (n=28), 10 years (n=28), 11 years (n=28) and 12 years (n=28). Offensive skills were coded from video for one quarter for three phases: 'Preparation' (moving into free space), 'Receiving' (catching the ball) and 'Releasing' (throwing or shooting).

Results

In the Preparation Phase, ‘No movement’ was used more frequently by younger players (p=0.006), whereas older players used ‘Sprinting forwards’ (p=0.010). In the Receiving Phase, younger players more frequently received the ball with 'Two Feet Grounded' (p<0.001), catching 'Within the Base of Support' (BOS) (p<0.001), then 'Pivoting after landing' to face their goal (p<0.001); whereas older players more frequently received with 'Two Feet in Flight' (p<0.001), catching 'Outside the BOS' (p=0.001), and 'Turning before landing' to face their goal (p<0.001). In the Release Phase, younger players more frequently threw 'High Lob' passes (p=0.007), from 'Above shoulder height' (p<0.001), using 'Two hands' (p=0.001); whereas older players showed faster release and a wide repertoire of passing techniques.

Discussion and conclusion

Between the ages of 8-12 years, junior netball players develop offensive skills including the ability to run into free court space at high speed, catch whilst jumping, catch outside the BOS, turn in the air before landing, land on one foot, throw with one hand using a wide repertoire of options, and perform a complete offensive play within 3 seconds. Therapists and coaches can use these results to (1) assess age-appropriateness of ball sport performance of school-aged girls, and (2) devise graded intervention strategies to support skill development and sustained participation in ball sports for girls with coordination difficulties.

Keywords: gross motor, assessment, sport-specific skills, participation
Relationship of ADHD Symptoms and Motor Skills in Children with DCD

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Background and aim

To examine the prevalence of attentional difficulties in children with Developmental Coordination Disorder (DCD) and to determine whether symptoms of Attention Deficit Hyperactivity Disorder (ADHD) (i.e., inattention and hyperactivity-impulsivity) are associated with fine and/or gross motor skills.

DCD is a neurodevelopmental disorder affecting 5-6% of school-aged children. Children with DCD have more attentional difficulties compared to typically-developing peers; up to 50% of children with DCD have ADHD. Previous literature attributed motor difficulties within the ADHD population to inattention and impulsivity; however, recent literature suggests that even with medication to address these symptoms, motor difficulties remain in a large majority of children. To date, few studies have examined the relationship between attention and fine/gross motor skills in children with DCD.

Method

Sixty-six children with DCD were assessed with the Movement Assessment Battery for Children-2 (MABC-2) and parents completed the Conners 3 ADHD Index for their child. Scores on the Conners 3 ADHD Index were separated into inattention and hyperactivity/impulsivity scores. Spearman correlations were calculated for MABC-2 scores (total, manual dexterity, ball skills, balance) with Conners ADHD Index scores (total, inattention, hyperactivity/impulsivity).

Results

Our findings show that 88% of children with DCD had elevated Conner’s T scores (≥70) or had an ADHD diagnosis. No significant correlations were found between Conner’s T score, inattention score, or hyperactivity-impulsivity score with MABC-2 total percentile or any subtest scores (all p > 0.05).

Discussion and conclusion

Children with DCD are known to have elevated attentional difficulties, even without a formal ADHD diagnosis. Results suggest that while inattention and hyperactivity/impulsivity are common in DCD, these factors are not significantly correlated with motor performance. These findings are consistent with Brossard-Racine et al. (2012), who reported that the majority of children with ADHD who had motor difficulties continued to have motor difficulties even after pharmacological treatment for ADHD. Our findings confirm that there is a high co-occurrence of DCD and ADHD, but that symptoms of inattention and/or hyperactivity-impulsivity are not significantly associated with motor performance. Children with ADHD who present with motor problems should be assessed for DCD and to receive appropriate intervention to address their motor skill deficits.

Keywords: motor performance, attention, ADHD
Quantifying DSM-V Criterion B for infants and young children aged 0-3 years: a systematic review of participation of measures

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Background and aim

The aim of this systematic review was to identify and examine the psychometric properties of outcome measures for participation for infants and young children with motor difficulties aged 0-3 years. Early diagnosis of DCD is extremely difficult, particularly given the need to verify DSM-V Criterion B, which requires the young child to present with a motor skills deficit that “significantly and persistently interferes with activities of daily living appropriate to chronological age (e.g., self-care and self maintenance) and impacts academic/school productivity, prevocational and vocational activities, leisure and play.” To verify this criterion in early diagnosis, valid and reliable measures of participation for infants and young children are needed. However, little is known about how best to measure participation for infants and young children.

Method

We performed a systematic review according to PRISMA Guidelines. Four electronic databases were searched to identify assessments that (i) measured at least one participation concept of ‘attendance’ and/or ‘involvement’ according to the Imms et al 2015 ‘Family of Participation Related Constructs’, (ii) with psychometric data for infants or children aged 0-3 years, and (iii) published in English in full text in a peer reviewed journal. Papers were reviewed by 2 independent raters. The COnsensus-based Standards for the selection of health Measure-ment INstruments (COSMIN) Checklist was used to evaluate quality and level of evidence. The CanChild Outcomes Measures Rating Form was used to rate clinical utility.

Results

Searches identified 1249 articles, of which seven outcome measures (14 studies) met the inclusion criteria: the Assessment of Preschool Children’s Participation, Canadian Occupational Performance Measure (COPM), Child Engagement in Daily Life Measure, Children’s Assessment of Participation with Hands, Daily Activities of Infants Scale, Test of Playfulness, and the Young Children’s Participation and Environment Measure.

Discussion and conclusion

All seven measures measured ‘attendance’ through diversity and/or frequency. Three also measured ‘involvement’. There was a paucity of psychometric data for all tests in the target age range. Three measures were designed for young infants and four were for children older than six months. Strongest psychometric properties were noted for the Child Engagement in Daily Life Measure, which is for children 18 months to five years. The COPM was the only measure with responsiveness data, however the goal identified needs to be a participation goal. Early psychometric evidence is available for seven measures of participation ‘attendance’ and/or ‘involvement’ for infants and young children with early motor difficulties. Further research is needed.

Keywords: young children, infants, participation, systematic review
Reproducibility of the Timed Up and Go (TUG) standard and dual task versions in school-aged children with and without coordination difficulties

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Background and aim

The aim of this study was to evaluate intra-rater and test-retest reproducibility of the Timed-Up-and-Go (TUG) standard and dual-task subtests in children with and without coordination difficulties. Developmental Coordination Disorder (DCD) is a neurodevelopmental disorder which is present in 5-6% of children. Poor postural control is thought to contribute strongly to these motor coordination difficulties. Sound assessment of postural control has been limited by assessments that do not have adequate psychometric data. Research is needed to establish the reliability of a common test of postural control: the 'Timed Up and Go'.

Method

Children were recruited for intra-rater (n=28, age 7-12 years) and test-retest (n=21, age 4-6 years) reproducibility evaluation of the TUG-standard (walk only), TUG-motor (walk carrying a cup of water) and TUG-cognitive (walk while counting). Motor function was quantified with the Test of Gross Motor Development (TGMD-2) percentile rank. Analyses were performed for TUG Trial-1, Trial-2 and Trial-average. Reproducibility was examined by reliability and agreement. Reliability of raw scores was examined using Intra-class Correlation Coefficients. Agreement of category scores for the TUG-standard and TUG-cognitive (from the Kids-BESTest) were examined using exact agreement, kappa, limits of agreement and smallest detectable change.

Results

Reliability of all TUG subtests was good-excellent for all intra-rater and test-retest analyses (ICC = 0.63-0.86), except intra-rater reliability of TUG-cognitive (ICC=0.44). For all subtests, data from Trial-2 showed better reliability than Trial-1 or Trial-average. Both the TUG-standard and TUG-cognitive showed excellent agreement (Kappa = 0.77-1.0).

Discussion and conclusion

This study provides new data on the reproducibility of the original TUG protocol and its motor and cognitive subtests for children. All three TUG subtests are reproducible clinical tools for children aged 4-12 years. During assessment, children should be provided with one practice turn, then the results of their second trial recorded. Further research is recommended to extend normative data and examine performance in response to intervention. The TUG-standard and its dual task subtests the TUG-motor and TUG-cognitive can be recommended for assessment of dynamic balance during gait in school aged children.

Keywords: Timed-Up-And-Go, DCD, Reproducibility, Dynamic balance
The Proprioception Profile Assessment and its relationship with fine motor performance in school-aged children

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Background and aim

The aims of this study were to (1) develop a comprehensive upper limb proprioception test battery for school-aged children, (2) establish normative profiles for test items with typically developing children according to age, gender, and hand dominance; and (3) investigate relationships between proprioception dimensions and fine motor performance. Although there is substantial literature reporting on visual and tactile dysfunction in children with Developmental Coordination Disorder and the impact that specific deficits have on upper limb function, less attention has been paid to proprioception. Clinical assessment of proprioception is not comprehensive for registration and perception, normative data is lacking, and it is unclear which dimensions of proprioception predict fine motor dysfunction.

Method

Participants were 25 children aged 6-12 years with typical motor development confirmed using the Movement Assessment Battery for Children (MABC-2). All children participated in upper limb assessment of: (i) proprioceptive registration, using the Passive Movement Direction Discrimination (PMDD) test for wrist and fingers; (ii) proprioceptive perception, using the Neurological Sensory Motor Developmental Assessment (NSMDA), the Position Sense Test (PST) for wrist and fingers, and Position Matching Test (PMT) for wrist and fingers; and (iii) fine motor function, using the Evaluation Tool of Children’s Handwriting (ETCH) and MABC-2 manual dexterity subscale (MABC-2-MD). Cohort performance on each test was examined using descriptive statistics. Comparisons between subgroups for age, gender and hand dominance were made using t-tests or Wilcoxin rank sum tests as relevant for the variable type. Then, relationships between proprioceptive measures and fine motor measures were tested using multiple regression modeling.

Results

In children older than 6 years, proprioception reached a level of maturity such that it was performed similarly regardless of age, gender or hand dominance. When considering the relationship with fine motor function, wrist proprioception (PST-wrist: p=0.032; PMT-wrist: p=0.019) explained 44% of the variance in manual dexterity (MABC-2). Finger proprioception (PMT-index dominant and non-dominant p=0.001) explained 72% of the variance in letter legibility (ETCH). Wrist and hand proprioception together explained 59% of the variance in word legibility (ETCH) and 52% of overall handwriting legibility (ETCH).

Discussion and conclusion

This is the first comprehensive proprioception assessment in children. Typically developing children aged 6-12 years show similar proprioceptive performance regardless of age, gender, or hand dominance. Wrist, hand and finger proprioception can predict manual dexterity and handwriting legibility. Further psychometric testing is warranted for clinical use with children with DCD.

Keywords: Fine Motor, DCD, Proprioception, School-aged
The Kids-BESTest of postural control predicts gross motor coordination in primary school children with and without coordination difficulties

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Background and aim

Poor postural control is thought to contribute strongly to motor coordination difficulties in children with Developmental Coordination Disorder (DCD). However, treatment of postural control has been limited by assessments that do not assess all postural control dimensions. Research is needed to explore the utility of new, more comprehensive assessments of postural control and relationships between postural control domains and motor coordination difficulties. Purpose was to (i) evaluate postural control in primary school aged children using the new comprehensive 'Kids Balance Evaluation Systems Test' (Kids-BESTest); (ii) compare results with a commonly used postural control subset assessment (Bruininks-Oseretsey Test of Motor Proficiency, Second Edition: BOT-2 Balance Subscale); then (iii) determine relationships between postural control on these tests with motor coordination (Test of Gross Motor Development, Second Edition: TGMD-2).

Method

Fifty-five children aged 4-12 years with normal intelligence attending mainstream schools participated in physiotherapy assessment of (i) postural control using the Kids-BESTest and BOT-2 Balance Subscale and (ii) motor coordination using the TGMD-2. Performance on each measure was examined using descriptive statistics (mean±SD). Relationships between measures were examined using Spearman’s Rank Correlation for categorical variables or Pearson’s Product-Moment Correlation for continuous variables. Linear regression was used to determine postural control and other factors predicting motor performance.

Results

TGMD-2 Total scores ranged from the 3rd to 97th percentile (mean 51st percentile) indicating the cohort included children with a wide range of motor abilities. Kids-BESTest Total scores ranged from 69 to 105 (64 – 97%) out of a possible 108 points (mean ± SD 92.4 ± 8.54 points; 86% ± 7.9%) indicating children also showed a wide range of postural control abilities. TGMD-2 Total scores correlated strongly with Kids-BESTest Total Scores (r=0.60, p<0.01) and moderately with BOT-2 Balance Subscale scores (r=0.45, p<0.01). Regression analysis showed that age and Kids-BESTest Total score predicted 44% of the TGMD-2 Total score (p<0.01) while the BOT-2 Balance Subscale predicted only 19% (p<0.01).

Discussion and conclusion

Results show that postural control predicts a substantial degree of the variance in motor performance in primary school aged children. The more comprehensive Kids-BESTest was a better predictor of motor coordination than the BOT-2 Balance Subscale which only includes a balance subset. Many children with motor coordination difficulties have postural control difficulties that contribute to their motor problems. We recommend use of the Kids-BESTest for a comprehensive postural control assessment for primary school aged children in order to plan more targeted interventions.

Keywords: Balance, BOT-2, Kids-BESTest, Postural Control
Parent participation in the Dutch Guidelines on diagnosis and intervention for children, adolescents and adults with DCD

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Background and aim

In the original text of the EACD recommendations on DCD, the subject of parent participation was mentioned indirectly and scarcely appeared within the recommendations. As the subject of family centered care and parent participation is essential in all pediatric care, the Dutch DCD guideline committee decided to formulate a scientific question to found our additional recommendations on this subject. Aim was develop evidence-based recommendations on parent participation for the Dutch guideline on diagnosis and treatment for DCD.

Method

According to the scientific question we formulated our search criteria in a PICO. Subsequently we did a search within the Medline and Embase database on the effect of parent participation in the DCD-treatment and the preference for a specific type of intervention on this subject.

Results

Initially we found 279 studies that met our search criteria. After reading all abstracts we selected 14 articles based upon relevance, for a full text study. Study designs were very diverse and differences in population and outcome measures made them hard to compare. Based on three studies left, we conclude that there are indications that parent participation enhances the knowledge and satisfaction of parents of children with DCD, and that motor skills improved after parent and teacher participation (within the intervention period).

Discussion and conclusion

Many studies on the subject of family centered care and parent participation are observational and show mainly associations and relations, but gather no hard evidence. The 3 studies left (Natrasony 2016, Ratzon 2009, Sugden 2003) were of low and very low evidential value, because of poorly defined patient populations, and a small study population. According to this and additional background information we formulated recommendations on how to inform and involve parents in diagnosis and treatment of children with DCD. Subsequently we wrote recommendations on evaluation of parent participation and outcomes of the intervention.

Keywords: parent participation DCD guideline
Physical activity parenting in children at-risk of developmental coordination disorder

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Background and aim

The support parents provide to their children’s physical activity (PA), i.e. physical activity parenting (PAP), plays a key role in children’s PA (Yao & Rhodes, 2015) and motor development. This study examined how parents provide support to their children who are at risk of developmental coordination disorder (DCD) compared to the parents with typically developing children.

Method

PAP was measured by mean frequency of self-reported support the parents provide weekly for their children via co-participation in PA, (in)direct support for PA, and encouragement for PA. Children’s (n=425; 6.25 ± 0.62 years) motor skills were measured by Körperkoordinationstest für Kinder (Kiphard & Schilling, 2007) and those belonging to the lowest 5th centile in the normalized motor quotients were defined as children with ‘probable DCD’ (pDCD) (n=24). Additionally, parents evaluated the child’s motor skills by answering to a tripartite question “When compared to the peers” motor skills are your child’s motor skills lower, equal or higher compared to the peers?” Differences in PAP, firstly, between the parents’ with pDCD child and the other parents, and secondly, between the parents evaluating child’s motor skills as lower compared to the peers and the other parents, were investigated by one-way ANCOVAs with child’s age and parent-reported health issue (yes / no) as covariates.

Results

Majority of the parents (70.7 %) with pDCD child evaluated the child’s motor skills as equal compared to the peers and minority of the parents (29.3 %) as lower compared to the peers. Generally, only 5.7 % of the parents (n=24) evaluated their child’s motor skills to be lower compared to the peers. PAP was found to be lower, although insignificantly, in parents with pDCD child compared to the other parents (mean difference -0.3 times per week). Parents who evaluated their child’s motor skills to be lower compared to the peers provided significantly less support for their children’s PA (mean difference -0.88 and -1.64 times a week) compared to the parents who reported their child’s motor skills to be equal or better compared to the peers.

Discussion and conclusion

There may be a detrimental interdependence between PAP and children’s motor problems: weak motor skills may discourage PAP, and low level of PAP may impede motor development. Early identification of the detrimental interdependence might enhance children’s motor development.

Keywords: parental support, movement skills, children, physical activity
Early caregiving, handling, positioning and motor play contribute to motor competence in healthy term infants

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Background and aim

The functional abilities of infants emerge in response to continuous dynamic interactions between genetics and early life experiences afforded in child caregiving. Infants are highly responsive to handling, positioning and motor play activities provided by their caregivers which may contribute to their motor development. Aim was to examine associations between early caregiving experiences and motor development in healthy term infants from birth to 10 months.

Method

A prospective birth cohort of 48 (24 male, 27 firstborn) healthy, term, infant-mother dyads were examined at infant’s age one, three and ten months old. Motor development was assessed using the Test of Infant Motor Performance, the Alberta Infant Motor Scale and Peabody Developmental Motor Scales-2. Infant handling skills of mothers were determined during routine care activities using the Infant Handling Measure, a valid kinematic tool developed for the study. The infants were classified into 2 groups; typical motor development (TMD) or late motor emergence (LME).

Results

Twelve infants (7 male, 9 firstborn) demonstrated LME (5 low average, 7 motor delay). At 1 and 3 months, infants with LME, demonstrated poorer postural control (p = .013; p = .003), prone abilities (p = .048; p = .04) and, at 3 months, reduced rotational movements (p = .024). At 1 month, their mothers were less competent handlers (p = .02), used fewer rotational movements (p = .034), demonstrated less variety in play (p = .018), provided less tummy time (p = .027) and used seating equipment (p = .032) more than mothers of TMD infants. At 3 months, mothers of LME infants provided less postural symmetry in holding (p = .059) and attended fewer parent enrichment programs (p = .042). At 10 months, infants with LME demonstrated delay in changing body position (p = .000) and moving independently (p = .000).

Discussion and conclusions

Findings from this study indicate that early care giving behaviours may contribute to LME. Infants who had mothers with low competence in infant handling had lower motor scores from an early age. Caregiver handling that exposes infants to rotational movements may enhance infants’ development of postural control during sensitive periods of sensory-motor neural maturation.

Conclusions: The persistence of lower infant postural scores at 3 months and delayed mobility scores at 10 months suggest there may be windows of opportunity to provide mothers with developmental specific motor play education across the first year of life.

Keywords: Motor development, Infant, Environmental enrichment, Parenting
Motor skills and executive functions of 3- to 5-year old preterm children

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Background and aim

In the last decades mild motor problems and specific cognitive difficulties without major deficits are the most dominant neurodevelopmental sequelae in children born preterm. This study aimed to explore motor skills and executive functions (EF) and their relationship in a group of preterm children 3- to 5-year old. In addition, we considered the comparison between Very Preterm (VP), born equal or less than 32 gestational weeks (GW) and Late Preterm (LP; 33-37 GW) children in each performance domain.

Method

The study was conducted on 48 preterms (76.6% males; Mean GW= 31.9 weeks, SD 2.6) at preschool age (M= 48.27 months of age, SD=6.9). Developmental assessment included: Coloured Progressive Matrices (CPM); the verbal intelligence Quotient (VIQ) from WPPSI-III; Battery for the Assessment of Executive Functions (BAFE) comprising measures of cognitive, attention flexibility, inhibition control and visual-spatial working memory; Developmental Test of Visual-Motor Integration (VMI); and Movement Assessment Battery for Children-2 (MABC-2) to identify motor function impairment. Data were analysed by using independent t-test of each measure; Chi-square to determine the occurrence of delayed performances into groups; and Pearson correlations among all variables.

Results

In the whole sample most of children gathered performances within the normal range for cognitive, motor abilities and EF. However, we found that 17.5% of children had potential motor problems, getting an MABC-2 "Total Score" that falls below the 16th percentile. In particular, 25%, 23.3% and 7.5% scored below the 16th percentile on "Manual Dexterity" (MD), "Aiming & Catching" (A&C) and "Balance" subtests respectively. Moreover, 30% reached a low performance at the motor coordination test of VMI. There are no significant differences between VP and LP on the percentage of children with potential motor problems. Considering the mean differences, we found that VP achieved significant lower scores than LP on MABC-2 "Total Score" (t=1.19; p=.04) and BAFE "visual-spatial working memory" task (t=2.08; p=.04). In addition, we found the following significant correlations: CPM related negatively to A&C (r=-.38, p<.05); VMI integration test related positively to MD (r=.43, p<.05).

Discussion and conclusion

Children born preterm seem to be at risk for motor problems, at pre-school age, in a considerable percentage. VP performed significantly poorer than LP in MABC-2 Total Score and visual-spatial working memory, whereas they are likely to display similarly across other domains. We suggest the importance to evaluate motor skills and EF at preschool age to detect difficulties earlier than primary school entrance and to plan early intervention.

Keywords: early assessment, executive functions, preterm children, motor problems
The DCD experience: Parental experiences in the diagnostic process of Developmental Coordination Disorder (DCD) in the Netherlands

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Background and aim
To identify factors that are related to parents’ satisfaction with the diagnostic process of Developmental Coordination Disorder (DCD), from the first concerns to receiving the DCD diagnosis, in the Netherlands. Receiving a diagnosis can have a major impact on the child and its family. Parental satisfaction concerning the diagnostic process is important with regard to acceptance and coping with their child’s problems.

Method
Parents of children with a DCD diagnosis in the Netherlands were invited to participate in an online survey. Parents (all mothers, mean(SD) age = 41.8(5.4 years)) of 60 children (mean(SD) age = 10.2(3.8) years) responded. On average, the children received a DCD diagnosis 3.9 years prior to completion of the survey. The survey included questions concerning background, (experiences during) the diagnostic process and the period after the diagnostic process. Completing the questionnaire took 20-30 minutes. Factors were identified based on (CAT)PCA. Spearman’s rank correlations (rho) were calculated to examine relations with parental satisfaction using a multiple correlations procedure. Multiple (stepwise) regression was used to identify the most important factors in predicting parental satisfaction with the diagnostic process.

Results
75% of the parents were (very) satisfied about the overall diagnostic process. The multiple correlations procedure revealed that the attitude of the professional involved in the diagnostic process, his/her perceived degree of expertise and post-diagnostic support (a follow-up appointment and the opportunity to ask questions) were the most important factors for the degree of satisfaction in parents. In addition, the extent to which parents experienced stress during the diagnostic process was an important predictor of satisfaction with this process (p = .02). The diagnostic process took on average 33.5 months (SD = 25.6 months). The duration was not related to the satisfaction of the parents, but the longer the duration of the diagnostic process the less parents experienced a feeling of understanding for the problems of their child.

Discussion and conclusion
The results underline the importance of increasing knowledge and awareness about DCD amongst professionals and for providing post-diagnostic support to parents. Although the majority of the participating parents indicated to be satisfied about the diagnostic process, it is essential that the duration of the diagnostic progress is reduced.

Keywords: Diagnostic process, DCD, Parental Satisfaction
Background and aim

Poor motor skill is an increasing issue for adolescents in our communities and recent research suggest 10% of children and adolescents have fundamental motor skills below that expected for their age. In 2012, almost 20% of Ballarat children starting school were considered developmentally vulnerable in at least one of five tested areas which include physical health (FMS), social competence, emotional maturity, language skills and communication skills. The aim of current study is exploring level of motor competence in adolescents in regional Victoria, using the Adolescent Motor Competence Questionnaire (AMCQ) (Timler et al, 2016), a questionnaire to report high (HMC) and low (LMC) motor competence (<83).

Method

A sample of 183 Australian adolescents (138 females, Mage = 14.44 years, SD = 0.75; 45 males, Mage = 14.44 years, SD = 0.75) completed the AMCQ.

Results

The mean AMCQ was 85.63 (SD = 6.98). Males had a higher AMCQ score (M = 87.64 SD = 6.62) than females (M = 85.06 SD = 7.07; t (174 = 2.09 p = 0.038).

A great proportion of adolescents reported HMC (n = 121), compared to LMC (n = 62). A Principal Component Analysis (PCA) resulted in extraction of five factors with an Eigenvalue (1.389) explaining 43.46% of variance. The Kaiser-Meyer-Olkin was 0.710 (p <.001), indicating the sample was suitable for analysis (Pallant, 2013) as it exceeded the recommended value of 0.6. The five factors represented Participation in Physical Activity and Sports; Activities of Daily Living; Public Performance; Peer Comparisons; Participation in Physical Activity and Sport at School. A General Linear Model analysis, with AMCQ score as the dependent variable, was completed for each item controlling for response category (positive or negative) and gender. There were significant differences (p<.001) in the participants’ mean AMCQ scores between response categories (positive or negative) for nearly all items. Most of those who responded negatively to items had lower AMCQ scores than those who responded positively. Significant differences (p<.001) in mean AMCQ scores were also evident between males and females for 18 items. A chi square analysis was significant for seven items, with a higher percentage of females compared to males responding negatively to five items, in particular, throwing a ball, and kicking a ball.

Discussion and conclusion

The results from this study highlights gender difference responses to aspects of motor performance need to be considered when designing interventions.

Keywords: AMCQ, Motor Competence
Contrasting atypical and typical developmental trajectories of reach-to-grasp movement with Movement-ABC and kinematic longitudinal data

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Background and aim

The use of kinematics uncovered that children with developmental coordination disorder (DCD) perform reach-to-grasp tasks more slowly and with wider grasping apertures that controls, especially when visual feedback is not provided (Biancotto et al., 2011). However, the developmental trajectories of how these phenomena unfold are under-investigated, leaving unclear whether, how and when adult-like reach-to-grasp movement stability towards stationary targets can be achieved in DCD.

Method

Using a 3D optoelectronic system (ProReflexMCU240, Version 6.42), we longitudinally tracked the kinematics of reach-to-grasp movements towards a wooden cylinder placed at the center of a table in two children with DCD and 25 healthy controls. Furthermore, we assessed children motor coordination skills via the MABC at the same time points. Children with DCD showed total scores at the MABC equal to or below the 15th percentile. All children were initially tested at 52-64 months of age and followed over 12 sessions, spaced 6 months from one another. The effect of distance and size of the target as well as the availability of visual information (eyes opened vs. closed) on the kinematics of the reach-to-grasp action was calculated.

Results

Results confirm that children with DCD show slower movement performance and larger grip apertures than healthy controls. Results also indicate that in all children both reaching (i.e., movement time and wrist trajectory) and grasping parameters (i.e., time to and amplitude of maximum grip aperture) are affected by development over time. The total MABC score represents for all children a significant predictor of the movement time and the amplitude of maximum grip aperture in the reach-to-grasp task, suggesting that the test is able to track subtle differences in coordination skills.

Discussion and conclusion

The kinematic approach allows to emphasize similarities and differences of the reach-to-grasp profile over the development of DCD and to compare it to typical development. The findings confirm that kinematic analysis is a reliable, objective index to monitor motor behavioral maturation in both typical and atypical developmental populations and could be used in diagnostic and treatment applications.

Keywords: Reach-To-Grasp, Movement-ABC Test, DCD, Kinematic Analysis
Prevalence of motor impairment in Autism Spectrum Disorder: Analysis of a population-based cohort

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Background and aim

There is mounting evidence to support motor impairment as a key clinical feature of Autism Spectrum Disorders (ASD). With prevalence reports as high as 79%, and delays in motor milestones preceding other clinical features, motor impairment appears to be an important clinical feature that may be overlooked in the diagnostic process. The present study examined the prevalence of motor impairment at time of diagnosis in an Australian cohort of children with ASD, along with factors in the ASD phenotype associated with motor impairment.

Method

Vineland Adaptive Behavior Scale (VABS) motor scores were examined in a sub-cohort of children aged ≤6 years from the Western Australian Autism Register (N = 2084; 81.2% males, 18.8% females). Motor scores were compared to other domains within the VABS (communication, daily living socialization), across DSM criteria, intellectual level, age and gender.

Results

A total of 35.4% of children scored in the low range on the motor skill subdomain of the VABS, and a further 43.7% in the moderately low range (combined total of 79.1%). This frequency was slightly lower than the other VABS subdomains, with 79.1% scoring in the low and 17.7% in the moderately low ranges for social skills (combined total of 96.8%), 62.3% scoring in the low and 29.3% in the moderately low ranges for daily living (combined total of 91.6%), and 65.7% scoring in the low and 24.9% moderately low ranges for communication (combined total of 90.6%). Whilst the prevalence of poor motor scores was high, motor impairment was only reported as a comorbid condition by diagnosing clinicians in 1.34% of the sample. Motor scores were lower in children diagnosed with ASD at a later age (p<0.001), and children with intellectual impairment (37.7% of the sample) had lower motor scores than those without (p<0.001). Examination of motor scores based on diagnostic criteria from the DSM revealed that those cases meeting the diagnostic criteria for impairments in non-verbal behaviour (i.e., body postures and gestures) and restricted and repetitive behaviours (i.e., motor stereotypies) displayed lower motor scores than those without.

Discussion and conclusion

The prevalence of motor impairment found in this large cohort was at least as common as one current diagnostic specifier. This highlights the need for further consideration of motor impairment within diagnostic evaluation for ASD.

Keywords: movement difficulties, Autism, motor impairment, prevalence
Systematic and meta-analytic reviews of intervention for children with DCD have more than doubled in the past 3 years: Has this increase in quantity been equalled by an increase in quality?

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Background and aim

Over the 20-year period from 1996 to 2015 only four systematic and/or meta-analytic reviews were published on the effects of intervention for children with DCD. In contrast, the past three years has seen this number more than double, raising the question of whether the increase in quantity is accompanied by a similar increase in quality. In 2016, we conducted a meta-review of the first four reviews. This investigation did show that the quality of successive reviews improved over time.

Method

In the present study, we have performed another meta-review on the recent four review studies published in 2016 and 2018. We evaluated the methodological quality of the four reviews, using the Assessment of Multiple Systematic Reviews, Second Edition (AMSTAR2), using two independent assessors.

Results

Most reviews revealed critical weaknesses, such as an inadequate literature search or a failure to assess risk of bias.

Discussion and conclusion

What we need in the future to determine how best to help children with DCD is to improve the quality of our intervention studies and reviews that we perform.

Keywords: quality of systematic review, quality of meta analysis, quantitative evidence, meta review
Predictors of community participation in preterm children at preschool age

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Background and aim

Preterm children (<37 weeks’ gestation) have higher rates of developmental coordination disorder (DCD) compared with children born at term. At school age, children with DCD have been found to participate less, and perceive greater barriers to participation, compared to their typically developing peers. Little is known about participation at preschool age for children at risk of DCD, particularly for children born preterm.

Aim: To explore how preterm birth affects community participation at 4 to 5 years’ corrected age, and to determine the affect motor impairment and social risk have on this relationship.

Method

42 very preterm (<30 weeks’ gestation) and 76 term children were assessed at 4 to 5 years’ corrected age for community participation, and perceived environmental barriers and supports using the Young Children’s Participation and Environmental Measure. Motor impairment was defined by a score ≤5th percentile on the Movement Assessment Battery for Children, 2nd edition, or a score of ≤67 (males) or ≤68 (females) on the Little Developmental Coordination Disorder Questionnaire. The Social Risk Index classified families as high or low social risk. Linear regressions were used to explore the relationships between preterm birth and participation outcomes, adjusted for motor impairment and social risk.

Results

Very preterm children participated less frequently in community activities (p<0.01) and faced more environmental barriers (p<0.01), compared with children born at term. There were no significant differences between quality of participation or perceived supports. Multivariate analysis, accounting for motor impairment and social risk, identified very preterm birth (β=-0.28, p=0.04, 95%CI -0.54 to -0.01) and high social risk (β=-0.45, p=0.002, 95%CI -0.72 to -0.16) as predictive of lower frequency community participation. Very preterm birth remained a significant predictor of environmental barriers (β=10.92, p=0.04, 95%CI 0.56 to 21.27). Motor impairment was not predictive of any aspects of community participation, including frequency and quality of participation as well as environmental barriers and supports.

Discussion and conclusion

Preterm birth affected frequency of community participation and barriers to participation, independent of motor impairment but not social risk. This is in contrast to research focusing on school age children, in which motor impairment is strongly related to lower rates of participation and increased perceived barriers. The significant influence of preterm birth highlights the importance of appropriate support for families with preterm children, particularly those classified as high social risk.

*Keywords: preschool age, motor impairment, participation, preterm birth*
Cross-modal attentional effects on somatosensory processing in adults with Autism Spectrum Disorders

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Background and aim

Atypical somatosensory processing is often reported in research on autism spectrum disorders (ASD), and it is stated that ASD is concurrent at a high rate with developmental coordination disorders (DCD). Somatosensory processing is very important in developing body image, sensorimotor skills, and motor coordination. However, some researchers state that individuals with ASD have abnormal attentional resource allocation, and it is possible that these attention problems affect the dysfunctions of body schema and movement. Therefore, we need to better understand the somatosensory neural activity related to attentional orientation. The aim of this study is to investigate the effects of visual attention on somatosensory processing in individuals with ASD.

Method

Six individuals with ASD (5 males, 1 female; mean age 20.8 ± 3.3 years) and six typically developing (TD) individuals (5 males, 1 female; mean age 23.0 ±1.3 years) participated in this study. To assess the neural activity of somatosensory areas, we measured somatosensory evoked potentials (SEPs) which were induced by the right median nerve stimulation. The SEPs were recorded on C3’ of the international 10-20 system. SEPs were assessed under three conditions (closed eyes, open eyes, and focused attention to a visual task) to investigate of the visual attentional effects.

Results

There were significant interactions between groups and conditions for the amplitudes of P100-N140 by repeated two-way ANOVA (p < 0.05). In addition, the P100-N140 amplitudes in the closed eyes condition were larger in ASD group than in TD group (p < 0.05). Furthermore, the P100-N140 amplitudes were significantly smaller for the focused attention to the visual task condition than for the closed eyes condition within ASD group (p < 0.05).

Discussion and conclusion

Our finding suggest that the P100-N140 component of SEPs in the ASD group was affected by the visual task. Many researchers state that individuals with ASD tend to overly focus on a single sensory stimulus to the exclusion of other stimuli. These results reinforce this belief. The ASD group concentrated more on the single stimulus compared to the TD group. Therefore, it is necessary to consider attentional direction in therapy targeting somatosensory processing.

Keywords: sensory processing, Autism Spectrum Disorder, Somatosensory evoked potentials, attention
Association between motor ability and motor function in children with high and low scores on the MABC-2

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Background and aim

The purpose of this study was to determine the association between motor ability and motor function in children with and without movement difficulties. The Physical and Neurological Examination for subtle signs (PANESS) was used to measure motor function and motor ability was measured using the Movement Assessment Battery for Children – 2nd ed. (MABC-2).

Method

34 children between the ages of 7 and 14 years (15 males, 19 females) participated in this study. The MABC-2 has 8 items divided into three components: Manual dexterity, Balance, plus Aiming and Catching. The PANESS is designed to measure noticeable components of motor function, such as lateral preference, gaits, balance, motor persistence, coordination, overflow, dysrhythmia and timed movements. Lower scores on the PANESS indicate no movement difficulties and higher scores indicate a risk of having movement difficulties.

Results

19 children had significant movement difficulties based on the MABC-2 scores (< 16th). Correlation analysis revealed significant, negative correlations between the MABC-2 total score and most of the components of the PANESS (Total Proximal Overflow: r = -.35, p < .05; Errors in Gaits: r = -.35, p < .05). Independent t-tests revealed between the MABC-2 groups indicated significant differences between children with significant movement difficulties and children without any difficulties for Errors in Gaits, Overflow in Stations, Total Dysrhythmia, and Total Overflow (all ps < .05).

Discussion and conclusion

In general, we found that lower scores on the MABC-2, which are associated with movement difficulties, correlated with higher scores on the PANESS, which also indicate more motor difficulties. While the MABC-2 is an assessment of motor ability and the most commonly used for identification of DCD, it is also correlated with several scores of motor function determined by the PANESS. Future studies should expand the analysis of the association between these two assessments in children with a wide range of motor ability and with different ages, and should determine the type of additional information about motor problems that can be gained from each assessment. This is significant as it may provide us with valuable information that can be used to assist with early assessment, identification, and intervention for children with motor difficulties.

Keywords: motor function, MABC-2, PANESS, motor ability
Actual and perceived motor competence in children with DCD: A case study

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Background and aim

The present study aimed to determine the relationship between actual and perceived motor competence in children with Developmental Coordination Disorder (DCD).

Method

Four children between the ages of 6 and 10 years, two males and two females, diagnosed with DCD, were evaluated with the Test of Gross Motor Development, 3rd edition (TGMD-3) and the Pictorial Scale of Perceived Motor Skill Competence (PSPMSC). The TGMD-3 is a process-based assessment of fundamental motor skills with two subtests (locomotor skills – run, gallop, hop, skip, jump, and slide – and ball skills – one-hand strike, two-hand strike, dribble, catch, kick, overhand throw, and underhand throw). The PSPMSC is based on the TGMD-3 skills, with two pictures showing children performing an activity (well or not well), where the child has to choose which picture is most like them. The options for the ‘good’ pictures include: ‘really good at’ or ‘pretty good at’; and for the ‘poor’ pictures included: ‘sort of good at’ or ‘not that good at’. This resulted in four possible levels of competence for each skill. We also administered a separate version of the PMSC for play skills (biking, scootering, skating, boogie board, swimming, and rope climbing), which were not associated with the TGMD-3.

Results

In general, perceived motor competence was high in both the fundamental motor skills and play skills of the assessment; however, the oldest child indicated significantly lower perceived competence in play skills. Actual motor competence was lower than average for all children, in both locomotor and ball skills. Relationship analysis demonstrated moderate correlations between the locomotor score and total score of the TGMD-3 and the PSPMSC-play skills.

Discussion and conclusion

The results indicated a lack of alignment between actual and perceived motor competence of children with DCD. However, their fundamental motor skills were moderately correlated with their perception of play skills. A possible explanation for these results are that the children did not have enough experience in play skills, concluding that their level of competence was low. However, young children perceived themselves as being ‘very good’ at fundamental skills, despite their results on the TGMD-3. These results add to the understanding of fundamental movement skills and perceived competence in this population. Our group is currently working on increasing the sample size and testing the effectiveness of a motor skill intervention to determine whether children with DCD can improve both their actual and perceived motor competence.

Keywords: TGMD-3, perceived motor competence, fundamental motor skills, PSPMSC
Dystypia: Prevalence and characteristics among students with dysgraphia

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Background and aim

This study examined the prevalence of dystypia among higher-education students with dysgraphia, compared to typically developing (TD) students. Specifically, we asked whether all students with dysgraphia also have dystypia, and if not, what differentiates between students who do and do not have dystypia.

Handwriting and keyboarding are two motor-learned transcription modes that require both similar and different processes. Therefore, one may hypothesize that students with motor disorders, who have handwriting difficulties (i.e., dysgraphia), may also have keyboarding difficulties (i.e., dystypia). However, little is known about the keyboarding performance of students with dysgraphia, and specifically among higher-education students, for whom the computer (via keyboarding) is an essential tool for participation in daily activities.

Method

The sample included 106 higher-education students between the ages of 18-33. Sixty had dysgraphia (Mage=24.20, SD=2.88) of whom 43 (71.6%) were males, and 46 were typically developing (TD; Mage=23.25, SD=2.24) of whom 17 (39%) were males. Students with dysgraphia had been diagnosed with a learning disability in childhood and demonstrated handwriting difficulties based on a standardized test (Z<-2) as well as lower (Z<-1) motor (Purdue), or grapho-motor (ROCF) skills. Students were individually administered a test battery including standardized handwriting, keyboarding, language, motor, grapho-motor and executive function tests.

Results

The percent of students with dystypia (typing speed of Z<-1.5) among the students with dysgraphia was 20% compared to 6.5% among the TD group. Comparison of students with both dysgraphia and dystypia and those with dysgraphia alone indicated that there were no significant differences in motor, grapho-motor and executive functions. By contrast, students with dysgraphia and dystypia scored significantly lower (p<.05) on phonological coding and orthographic awareness and were significantly slower handwriters.

Discussion and conclusion

Students with dysgraphia are 3 times more likely to have dystypia compared to their normally achieving peers. Students with both dysgraphia and dystypia are slower handwriters and have lower linguistic functions but not lower motor or executive functions. These results support models suggesting that handwriting and keyboarding share linguistic processes, but differ in cognitive and motor processes. The findings also suggest that for students with lower handwriting speed and linguistic functions, keyboarding may not be a sufficient alternative writing mode. However, these results are preliminary and focused only on keyboarding speed. Additional studies are warranted, including examination of students with poor keyboarding accuracy.

Keywords: Language, Motor, Dysgraphia, Dystypia
Strengths in people with DCD – pilot study

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Background and aim

Developmental coordination disorder (DCD) is a neurodevelopmental disorder which affects individual’s motor skills, activities of daily living, executive functions and organisational skills. There is hardly any research on strengths of people with DCD. Most commonly associated strengths with DCD are verbal skills, imagination, and prosocial skills. Some researchers also add communicative skills, computer literacy, early reading and writing skills, excellent logical assumptions, and math skills.

Method

The aim of our study was to determine most common strengths in people with DCD. Two parallel pilot studies were done, one examining strengths in children just having been diagnosed with DCD, and one examining self-reported strengths of adults with DCD. In the first study, we examined 50 Slovenian children aged 5 to 15, male to female ratio approximately 6:1. Most of them had associated disorders such as SLD, ADHD/ADD or ASD (assessed by a team of experts in children and self-reported in adults). In our second study, we conducted a research via social media, through English spoken support groups. We received responses from 61 diagnosed or self-diagnosed adults with DCD. Most of them had comorbid disorders as well. Male to female ratio was 1:3.

Results

In the first study, results based on professional assessment showed imagination, verbal skills, common knowledge and problem solving being the most common strengths. Good math skills were often assessed as well, especially in children with comorbid conditions. In the adult study, research showed that most common self-assessed strengths were thinking out of the box, empathy, imagination, creativity, long-term memory, trivia recall, problem solving and verbal skills, while good math skills were not that common. Comparison between results of both groups showed some common strengths, namely imagination, verbal skills and problem solving. Sample analysis shows that in the adult group sample, there were more individuals with specific learning disabilities in math, ASD comorbidity was more common in our sample of children. Furthermore, there were more women than men in the adult group, as opposed to more boys than girls in the other group.

Discussion and conclusion

Our study showed specific intra-group differences that need further discussion and research. We contribute differences in results to differences in sampling. Further study into DCD strengths will be applied, first locally, then internationally for different samples of people with DCD. Our study is one of rare studies into DCD strengths, and has an important scientific value for further research into DCD.

Keywords: adults, children, DCD, strengths
Underlying Neural Mechanisms of Handwriting Pauses in The Detailed Assessment of Speed of Handwriting (DASH) Test

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Background and aim
To investigate the underlying neural mechanisms of handwriting pauses in children with DCD, using functional near infrared spectroscopy (fNIRS). Handwriting difficulties is one of the chief reasons for referral of children with DCD to clinicians and an important diagnostic criterion for DCD. Handwriting is an essential component of expressing ideas, knowledge and experiences and handwriting difficulties can negatively impact child’s academic performance. Previous studies have shown that the percentage and location of the pauses in children with DCD significantly differ with their typically developing peers. Higher cognitive processing demands, fatigue, movement difficulties and/or some combination of these have been proposed as possible underlying factors that might result in these differences.

Method
To investigate the neural mechanisms that give rise to these differences, we administered two subtests (Copy Best and Copy Fast) of Detailed Assessment of Speed of Handwriting (DASH). Seven healthy college students between the ages of 18-22 completed DASH with scores ranging from 31st – 98th percentile, all indicating no difficulties with handwriting speed. Then the subset of copying a sentence containing all letters of alphabet was explored further while fNIRS was used to collect Brain Oxygen-Level-Dependent (BOLD) from the prefrontal cortex (PFC). Order of tasks were randomized, and each task lasted for 1 minute with rest periods jittered between 12-18 seconds before and after each task. Pauses were defined as pen lifts from the tablet and were categorized as short (30-250 ms) or long (251-2000 ms).

Results
Copy best had significantly higher BOLD activity (p<0.05) as well as significantly more frequent, longer pauses than the copy fast. Also, a significant difference between tasks in frequency of pauses existed with a greater frequency of longer pauses in copy best (p<0.003) and greater frequency of shorter pauses in copy fast (p<0.03).

Discussion and conclusion
The results show that there is a higher cognitive workload during the copy best than the copy fast, resulting in greater changes in BOLD and longer pauses. This implicates higher cognitive processing demands as a potential underlying element that may give rise to longer and more frequent pauses. The future investigations will focus on the clinical populations including DCD and ADHD to investigate whether the underlying mechanism of pauses is due to higher cognitive processing demands.

Keywords: fNIRs, DASH, assessment, pauses
Cortical substrates of a neuropsychological test of manual dexterity using Functional Near Infrared Spectroscopy

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Background and aim

The aim of this study was to use fNIRS to determine the sensitivity of four sub-tests of Purdue Pegboard Task (PPT) for differentiating between the ADHD subtypes. Manual dexterity is compromised in children with Developmental Coordination Disorder (DCD). Functional Magnetic Resonance Imaging (fMRI) studies have previously demonstrated the differential activation of brain regions in children with DCD during manual dexterity tasks. Current body of Neuroimaging literature assessing manual dexterity in children with DCD has mainly focused on finger tapping or tracing tasks and has not explored the intricacies associated with fine motor, cognitive planning and working memory that is associated with clinical evaluation methods of manual dexterity. One contributing factor to this gap in the literature has been the restrictive nature of fMRI studies that require subjects to stay very still and poor spatial resolution associated with techniques such as EEG. Unlike fMRI and EEG, functional near infrared spectroscopy (fNIRS) is a non-invasive neuroimaging technique that can capture blood oxygen-level dependent (BOLD) activity during ecologically valid movements.

Method

In order to understand the cortical underpinnings of manual dexterity, we used fNIRS to study PPT. PPT is a valid and reliable clinical test used to evaluate manual dexterity in pediatric population. This test includes four sub-tests: preferred, non-preferred, both hands (moving pegs into board) and assembly (assembling washers and collars). PPT is sensitive not only to fine motor skill, but also to working memory and cognitive planning. In this study, 10 healthy adults (7 males, 3 females, age range 18-35y) performed PPT while fNIRS data were collected in a randomized block design for 3 sets from the Prefrontal Cortex (PFC).

Results

One-way ANOVA with Post hoc analysis won BOLD activity indicates that there was a significant difference between sub-tasks (p=0.03) stemming from task complexity. There was a significant difference in the average BOLD activity between the assembly and all other conditions (p<0.01).

Discussion and conclusion

These results indicate that sub-tests differ in neural demands and task complexity impacts overall neural activity in the PFC. Our results suggest that the assembly subtest may provide a more sensitive measure to examine both motor and executive (dys)function in neurodevelopmental disorders such as DCD and ADHD.

Keywords: prefrontal cortex, Purdue pegboard, fNIRs
Innovative Developmental Motor Coordination Program READY SET GO – Catch the Milestone

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Background and aim

Physical activity is the most characteristic and dominant component in the early development of each child. For the very young child physical activity represents the basic and most supportive "tool" for developing other more complex learning skills. The Ready Set Go (RSG) program is founded on the belief that age relevant motor skill development and self-esteem are prerequisites for school readiness. The RSG aims to offer comprehensive programs in integrating basic skills which will provide the foundation for future learning.

Method

The RSG program consists of two main components, A and B:

A – Ready Set Go Screening test for 3.5–4.5–5.5 year old children. The test identifies children (from their classroom population) who have not reached their motor development milestones. The criteria is based on the WHO development motor milestones for 4, 5, and 6 year old children. B – Ready Set Go Program for 3–7 years old children, selected by Ready Set Go Screening Test. The test remedies, compensates and enriches motor coordination skills to maximise children’s potential to reach their developmental milestones and to improve their ability to learn. The assessment was undertaken from September 2018 to October 2018 in the Kindergarten "Iskierka" in Cracow (Poland). From October 2018 to March 2019, an early intervention – the RSG developmental motor coordination program was conducted. The study group consisted of 121 children, mean age was 5 years of age.

Results

During 6 months of the RSG program we noticed significant improvements, especially in the development of gross motor and general coordination in the oldest groups of children (Milestone Criteria WHO). Before the RSG program, 61 children (50%) had significant problems and lagged behind in skills; 41 (67%) boys; 20 (33%) girls; 60 other children had satisfactory results and some were good. There were no above average results. In the re-assessment (N=121), 24 children (20%) had some difficulty and lagged in skills; 18 (75%) boys; 6 (25%) girls; 97 other children had good results (comparable to average in the general population) and some achieved above average results.

Discussion and conclusion

With the RSG program we expect to improve motor skills – the foundation for future academical achievements. Through hopping, jumping or skipping we create children’s body awareness, spatial awareness, motor coordination, motor planning, visual language, pre-literacy and pre-numeracy skills, memory, social interaction, attention, motivation, concentration, confidence and finally high self-esteem.

Keywords: self esteem, cognitive, motor coordination, developmental
Movement activity for pre-schooler children following the Australian "Animal Fun": an Italian proposal

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Background and aim

In our society children’s motor activity is decreasing, in favour of technological and static games. In early childhood they already risk of having a sedentary lifestyle, lacking in the essential motor skills. "Animal fun" is an imaginative Australian program, which builds fine and gross motor skills in young children. It has been designed for children aged between 3 and 6 years old. In Italy there is a lack of these programs. In our country the problem of inactivity is diffused, and interventions to promote movement and health are required, especially for young children.

Method

With the consent of the authors, the Australian "Animal Fun" had been translated into Italian, without any modifications. After the approval of the Ethics Committee, and after the written informed consent from the parents, 136 children of three different Italian Kindergartens were included. Randomly considering the Kindergarten, they were divided into "Case" (76 children; mean-age=4.68, sd=0.89; 39 males) and "Control" (60 children; mean-age=4.44, sd=0.94; 32 males) groups; none were excluded. At the baseline and after a month, we assessed both groups through the Movement Assessment Battery for Children-2. This assessment consists of: Manual Dexterity, Aiming and Catching, and Balance. It also provides a total motor skill score. The Case group followed a four-weeks program with a physiotherapist, who provided "Animal Fun" three-times a week, for 30 minutes. We included this activity in the everyday scholastic program, in order to involve the teacher in understanding the importance of the motor development. The non parametric Mann-Whitnet test had been provided.

Results

At the baseline the groups did not show statistical significant difference for the motor scores. After one month, the Case group demonstrated significant difference for all the evaluated skills: Manual Dexterity (p-value=0.01878), Aiming and Catching (p-value<0.0001), Balance (p-value<0.00001), total score (p-value<0.00001). The Control group did not demonstrate significant difference for: Manual Dexterity (p-value=0.12321), Balance (p-value=0.41733), total score (p-value<0.18771). The Aiming and Catching skill showed a significant improvement also for the Controls (p-value<0.00001).

Discussion and conclusion

The results demonstrate that "Animal Fun" is completely applicable to Italian young children. By participating in this program the children’s score improved in Manual Dexterity, Balance and total motor scores. The inclusion of this kind of activity in the Italian pre-school program could be very useful to improve children’s motor abilities. This innovation could help the children to increase their desire to move, to learn more about their body and to experiment new motor experiences.

Keywords: children, motor development., physical activity
Strategies of adults with DCD to deal with the condition

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Background and aim

Some symptoms of Developmental Coordination Disorders may diminish or alter in adulthood. It could be related with adults’ ability to develop coping mechanisms to deal with those disabilities. The aim of the present study was to identify adults with or at risk of having DCD and to describe the strategies used in childhood and/or adulthood to deal with the difficulties commonly reported.

Method

A convenience sample of 288 adults aged 19–70 (161 males [55.9%]; 127 females [44.1%]) was used. The Adult Developmental Co-ordination Disorders/Dyspraxia Checklist (ADC), based on the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV; American Psychiatric Association, 1994), was used to identify adults that are at risk for DCD. It is a 40 item questionnaire designed for 17- to 42-year-olds (Kirby et al., 2010) and requires participants to report on current and past movement difficulties. The psychometric properties of the ADC showed good internal consistency, construct and concurrent validity and discriminant validity.

Results

The questionnaire identified 28 adults (15 females and 13 males; ratio: 1:1,15) at risk of DCD (9,7%) and 10 (5 females and 5 males; ratio: 1:1) with probable DCD (3,4%). The results revealed that self-reported strategies were related to spending more time to do the tasks. Also, they made use of specific strategies to perform tasks in a more efficient manner (such as making use of various assistive applications on cellular phones or using an alarm clock), consistent with other studies (Missiuna, et al. 2008; Lee & Bo, 2015).

Discussion and conclusion

considering the percentage of individuals with probable DCD found in this study it is possible to conclude that it is lower than the percentage identified by DSM-5 (5%) in childhood and adolescence. Encouraging teachers and therapists to use these strategies could assist children with DCD in adapting to the environment. Taking into account the developmental nature of this condition, we recommend future studies to explore the meaning of DCD to adults themselves during their lifetimes.

Keywords: Strategies, Developmental coordination disorder, Adulthood, Adult Developmental Co-ordination Disorders/Dyspraxia Checklist
BOMO-test: test development for evaluating 4-6-year-old children’s motor performance

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Background and aim

The study aim was to develop an assessment tool for 4-6-year-old children to identify motor learning problems and related cognitive problems. In addition, the BOMO test is applied to developing process-oriented interventions.

Method

First, the contents of nine existing motor skill assessment tools were analyzed. Secondly, based on the review, a motor test, the BOMO, was developed. It consists of 12 items: body awareness (2), balance (4), catching and throwing (2), manual dexterity (2) and dual and triple tasks combining cognitive and motor components (2). The BOMO was administered to a total sample of 906 children (the mean age 5.1 years, SD 0.41, 48% boys, 52% girls). Full test results were available from 880 children. The sample was divided into four age groups: 4.00-4.50 years (n=73), 4.51-5.00 years (n=294), 5.01-5.50 years (n=329) and 5.51-6.00 years (n=97). Reliability analyses were carried out by two testers by examining 55 simultaneous codings (r=.844 -.992, p=.01), 30 retests (r=.823, p = .01) and 38 video analyses (test-retest and inter-tester consistency 86-96%). For the validity analysis, 29 children were assessed by both MABC and BOMO. No significant differences were found in the total scores or in comparable items of MABC and BOMO.

Results

The process-oriented analysis of the nine tests showed that although they included the most important motor control elements, their manuals often exclude a thorough explanation of the meaning of the test items as well as what test failure indicates. In the BOMO test, poor performance in body awareness and body control items correlated with poor performance in balance items, skipping, and the total score – especially in children older than 4.5 years. Gender differences were significant (p = .000 – .05) in several items and the total score, especially at the age of 4.5-5.5 years. Consequently, separate performance criteria were established for boys and girls. Children who failed in the dual or triple tasks obtained poor results in several items and had a low total score. Similar to other motor tests, the cut-off points of the BOMO test item scores and total score were set at 5% (gender ratio 2:1) and 15% (gender ratio 4:1).

Discussion and conclusion

Problems in single BOMO test items indicate mild motor problems and the child’s development may be supported as part of daily activities. A low BOMO total score indicates wide-ranging motor problems requiring specific interventions. BOMO takes 15-20 minutes to complete and its feasibility is good.

Keywords: motor skills assessment, motor performance, motor control, developmental coordination disorder
Motor competence according to the Movement ABC-2 in very preterm born children at 12 years of age and their parents’ ability to identify motor problems with the DCDQ’07

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Background and aim

Long term follow-up of children born preterm frequently demonstrate persisting motor problems throughout childhood and in to the adult years. It is important to identify these children since the poor motor functioning can lead to low self-confidence and self-efficacy as well as have a clear association with obesity and general inactivity. The objective of this study was to evaluate the motor competence in 12-year-old children born very preterm compared to full-term born controls and study the effect of gender and level of prematurity. In addition, the parents’ ability to identify the motor difficulties of their children was explored.

Method

The motor competence of 53 very preterm born children (gestational age, GA <32 weeks) and 34 controls were assessed with the Movement Assessment Battery-Second Edition (The Movement ABC-2). The scaled scores on the domains: manual dexterity, aiming and catching and balance as well as the total test scores were used to calculate differences between the groups. The relation between the parent’s answers on the Developmental Coordination Disorder Questionnaire 2007 (The DCDQ’07) and the results of the Movement ABC-2 was studied.

Results

Very preterm born children scored statistically significantly lower than the controls in all domains according to the Movement ABC-2. There was no statistically significant difference within the preterm group for gender or degree of prematurity. However, the mean value was lower in all domains for the extremely preterm born children (GA <28 w) compared to those born at GA 28-31 w. In the very preterm group, 18/53 (34%) scored <15th percentile according to the Movement ABC-2 total scores. The corresponding numbers for the controls were two out of 34(6%). The response rate of the DCDQ’07 was 44 questionnaires from the preterm group and 34 from the control group. In the preterm group, 14/ 44 children belonged to the group with motor difficulties according to the Movement ABC-2. Ten(71%)of these had parents that identified their children with motor difficulties according to the DCDQ’07. The corresponding number in the control group was one of two.

Discussion and conclusion

Very preterm born children display a lower level of motor competence as assessed by the Movement ABC-2 compared to term born controls. Gender or gestational age did not effect motor performance in the preterm group. Most parents to children born very preterm can identify their children’s motor difficulties and can play a positive role in supporting the needs of these children.

Keywords: parents, preterm, motor competence
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