

# Developmental Coordination Disorder International Conference, DCD IX - Lausanne 2011

## Thursday 23 June 2011 / Auditoire Yersin

7:45-8:30

Welcome / Registration

Chairman : Professor Peter Wilson

Welcome to DCD-9 and introduction conference by Professor Pierre-François Leyvraz,  
General Director of University Hospital of Lausanne

### Diagnosis and assessment

8:50-9:30

#### **Revision of the diagnosis for DCD criteria of the DSM-IV**

Doctor Rainer Blank, University of Heidelberg (Germany)

9:30-9:50

#### **Addressing lack of awareness and knowledge of DCD: Results and implications of a public marketing survey**

Brenda Wilson, University of Calgary (Canada)

9:50-10:10

#### **Identification and prevalence of four year old Australian children at risk for DCD**

Elizabeth Pridham, University of South Australia (Australia)

10:10-10:30

Coffee break

10:30-11:15

#### **Short oral presentation of posters – session A: Epidemiology, Diagnosis and Assessment**

11:20-11:40

#### **The Movement ABC-2 checklist: an item analysis and examination of construct validity**

Anna Barnett, Oxford Brookes University (UK)

11:40-12:00

#### **Assessment of activities of daily living in children with DCD - Psychometric properties of a new test: the DCDDaily**

Berdien W. van der Linde, University of Groningen (Netherlands)

12:00-1:00

Lunch

### Longitudinal study, etiology and comorbidity

Chairman : Professor David Sugden

1:00-1:40

#### **Neuromotor development from early childhood through late adolescence: findings from the Zurich longitudinal studies**

Doctor Oskar Jenni, University Children's Hospital Zurich (Switzerland)

1:40-2:00

#### **Movement skill characteristics of preschool children referred to a clinical service**

Dido Green, Tel Aviv University (Israel)

2:00-2:20

#### **Longitudinal assessment of psychological distress in adolescents with DCD**

Christine Rodriguez, McMaster University (Canada)

2:20-2:40

#### **Individual differences in IQ profiles of children and adults with DCD**

Elisabeth Hill, Goldsmiths, University of London (UK)

2:40-3:00

#### **Motor, cognitive and behavioral differences between children with severe motor difficulties and moderate motor difficulties**

Marina M. Schoemaker, Centre for Human Movement Science, Groningen (Netherlands)

3:00-3:30

Session poster A discussion and coffee break

3:30-3:50

#### **Are scholastic skills impaired in children with motor coordination problems?**

Stefanie Pieters, Ghent University (Belgium)

3:50-4:10

#### **Planning and organizational abilities among adults with DCD**

Sara Rosenblum, University of Haifa (Israel)

4:10-4:30

#### **Exposure to second-hand smoke during pregnancy and DCD**

Nadilein Mahlberg, McMaster University (Canada)

4:30-5:00

#### **Neuromotor outcome of premature children in Lausanne**

Doctor Myriam Bickle-Graz and Doctor Manon Cevey Macherel, University Hospital of Lausanne, (Switzerland)

5:00-6:00

Meeting of The International Society of Research into DCD (*open to everyone*)

Congrès reconnu par :

La Société Suisse de Pédiatrie (20 crédits) ; physioswiss (21 points)

# Developmental Coordination Disorder International Conference, DCD IX - Lausanne 2011

## Friday 24 June 2011 (AM)

### Auditoire César-Roux

*Traduction simultanée anglais-français*

#### Neuroimaging

Chairwoman: Professor Eliane Roulet Perez

8:30-9:10

#### **FMRI with children with DCD**

Professor Patrick Berquin, Pediatric Neurology, University Hospital Amiens (France)

9:10-9:30

#### **Neural mechanisms of motor overflow in children with DCD: A functional MRI study**

Melissa Licari, The University of Western Australia (Australia)

9:30-9:50

#### **Attention and motor preparation in adults with DCD: An EEG study.**

Ellisabeth Hill, Goldsmiths, University of London (UK)

9:50-10:10

#### **Prognostic aspects of ADC values in newborns with moderate asphyxia**

Doctor Juliane Schneider and Doctor Anita Truttmann, University Hospital of Lausanne (Switzerland)

10:10-10:30

Coffee break

10:30-11:15

**Short oral presentation of posters - session B: Neuroimaging, perceptual and motor skills, physical activity**

11:20-12:00

#### **Results of a cognitive remediation: FMRI-study with ADHD adolescents**

Doctor Michel Bader, University Hospital of Lausanne (Switzerland)

12:00-1:00

### Auditoire Auguste-Tissot

*Pas de traduction*

#### School performance and mechanism

Chairman: Doctor Christopher Newman

9:10-9:30

#### **Developmental Coordination Disorder and academic performance: A longitudinal study using a large sample of children in a public school setting in Canada**

Scott Veldhuizen, Centre of Addiction and Mental Health, Toronto (Canada)

9:30-9:50

#### **The mediating influence of physical fitness on the relationship between academic performance and motor proficiency**

Ryan Alexander, Brock University (Canada)

9:50-10:10

#### **Do children with motor deficits accurately predict their action gaps?**

Catherine Purcell, Royal Holloway, University of London (UK)

10:10-10:30

Coffee break

10:30-11:15

**Short oral presentation of posters - session C: Motor control and physical activity**

Lunch

## Auditoire César-Roux

Traduction simultanée anglais-français

Friday 24 June 2011 (PM)

## Auditoire Auguste-Tissot

Pas de traduction

## Perceptual motor coordination

Chairwoman: Professor Amanda Kirby

1:00-1:40

**Development of coordination during childhood**

Professor Karl M. Newell, Department of Kinesiology, The Pennsylvania State University (USA)

1:40-2:00

**The relationship between the development of movement skill, online control and executive control in children: A longitudinal investigation**

Peter Wilson, RMIT University (Australia)

2:00-2:20

**Impaired online control in children with DCD reflects developmental immaturity**

Christian Hyde, Victoria University (Australia)

2:20-2:40

**Impaired visuo-motor sequence learning in children with DCD**

Freja Gheysen, Gent University, University College Arteveldehogeschool (Belgium)

2:40-3:00

**Optimal timescales for visuomotor control in DCD**

Rita de Oliveira, Royal Holloway University of London (UK)

**3:00-3:30 Session poster B, discussion and coffee break**

3:30-3:50

**Postural responses of DCD and TDC children to tasks demanding perceptual and cognitive effort**

Michael Wade, University of Minnesota (United State)

3:50-4:10

**The effect of task and individual constraints on affordances for walking in Children with DCD**

Sarah Astill, University of Leeds (UK)

4:10-4:30

**Are motor imagery deficits evident in children with both DCD and ADHD**

Jacqueline Williams, Victoria University (Australia)

4:30-4:50

**The effect of visuo-motor complexity on movement in children with varying motor abilities**

Noëmi Cantin, University of Toronto (Canada)

4:50-5:15

**External feedback: a power tool for enhancing the learning of motor skills ?**

Doctor Christopher Newman, MD Pediatric physiatrist, University Hospital of Lausanne (Switzerland)

## Physical activity and motor coordination

Chairwoman: Doctor Manon Cevey-Macherel

1:40-2:00

**Changes in self-perception of physical appearance and athletic competence in children with DCD over Time**

Divya Joshi McMaster University (Canada)

2:00-2:20

**The action-perception dynamic patterns in an accuracy throwing task of school of children at risk for DCD**

Margareth Monteiro, University Federal do Rio Grande do Norte (Brazil)

2:20-2:40

**Oxygen cost during incremental exercise in children with DCD and controls**

Irina Rivlis, Brock University, St. Catharines (Canada)

2:40-3:00

**Left ventricular structure and function in children with and without DCD**

Daniele Chirico, Brock University (Canada)

**3:00-3:30 Session poster C, discussion and coffee break**

3:30-3:50

**Temporal stability of visually induced postural stability DCD**

Hyun Chae Chung, Kunsan National University (Rep of Korea)

3:50-4:10

**Diffusion tensor imaging of children with DCD: A pilot study**

Jill Zwicker, University of British Columbia (Canada)

4:10-4:30

**Age-related differences in motor inhibition of symmetrical movements in children with DCD during a switching task**

Jérôme Barral, University of Lausanne (Switzerland)

4:30-4:50

**Visual tracking behaviour and movement kinematics during catching in Children with DCD**

Melissa Licari, The University of Western Australia (Australia)

Conference banquet at 7pm

# Developmental Coordination Disorder International Conference, DCD IX - Lausanne 2011

## Saturday 25 June 2011 (AM)

### Auditoire César-Roux

*Traduction simultanée anglais-français*

#### Physical activity, intervention and handwriting

Chairman: Professor Michael Wade

8:30-9:10

#### **Developmental Coordination Disorder, activity and physical health in children; current findings, future directions**

Professor John Cairney, McMaster Family Medicine Professor of Child Health Research, McMaster University, Hamilton (Canada)

9:10-9:30

#### **Improving fitness and motor skills in adolescents with DCD: Preliminary results from the AMPitup program**

Beth Hands, University of Notre Dame Australia (Australia)

9:30-9:50

#### **Motor intervention as a strategy to improve motor deficits among school children with ADHD**

Anita Pienaar, North-West University (South Africa)

9:50-10:10

#### **Clinical change following a 13 week intervention program for children with DCD**

Emily Ward Curtin University (Australia)

10:10-10:30

Coffee break

10:30-11:15

#### **Short oral presentation of posters - session D: Assessment, School, and Handwriting**

11:20-11:40

#### **Persisting motor and handwriting difficulties in children with ADHD following pharmacologic treatment**

Marie Brossard-Racine, McGill University (Canada)

11:40-12:00

#### **Graphomotor disorders in children with autism spectrum disorders: due to impaired Motor functioning**

Tinneke Hellinckx, Ghent University (Belgium)

### Auditoire Auguste-Tissot

*Pas de traduction*

#### Intervention, participation and family

Chairwoman: Doctor Myriam Bickle Graz

9:10-9:30

#### **Developing a care pathway for children with DCD**

Christine Owen, Queen Margaret University (UK)

9:30-9:50

#### **Building clinical expertise in DCD through a community of practice**

Brenda Wilson, Alberta Health Services and University of Calgary (Canada)

9:50-10:10

#### **Multidisciplinary implementation of task oriented approaches for children with DCD: National Dutch example of change management in professional reality**

Jolien van den Houten, Zuyd University of Applied Sciences (Netherlands)

10:10-10:30

Coffee break

10:30-11:15

#### **Short oral presentation of posters – session E: Parents, Quality of life, and Intervention**

11:20-11:40

#### **Family-focused tele-intervention for children with DCD: development and lessons learned**

Motohide Miyahara, University of Otago (New Zealand)

11:40-12:00

#### **The relationship between DCD, child's perceived self-efficacy and preference to participate in leisure activities**

Batya Engel-Yeger, University of Haifa (Israel)

## Developmental Coordination Disorder International Conference, DCD IX - Lausanne 2011

### Saturday 25 June 2011 (PM)

1:00 - 1:35pm

#### Workshops

César-Roux <i>Traduction en français</i>	<b><i>Motor skills, working memory, and academic achievement in a normal population of adolescents: a test of a mediating model</i></b> Daniela Rigoli, Curtin University (Australia)
Auditoire Tissot	<b><i>Évaluation écosystémique des besoins des enfants avec un TAC au primaire pour favoriser leur participation sociale et leur accomplissement de soi</i></b> Emmanuelle Jasmin, Université de Sherbrooke (Canada)
Salle Andros	<b><i>Les difficultés de l'enfant dyspraxique à la maison et à l'école et les aides applicables dans leur vie quotidienne</i></b> Corinne Masson-Friedli, présidente de l'association Dyspra quoi (Suisse)
Auditoire Yersin	<b><i>Wirklich eine UEMF? Differential Diagnose der Motorischen Funktion</i></b> Félicitas Steiner, Kinderklinik, Kantonsspital Aarau (Schweiz)
Salle séminaire 2	<b><i>Classroom public speaking on DCD; peers experience hands-on the meaning of poor motor performance</i></b> Annelies de Hoop, REC Midden Brabant (Netherlands)

Salle séminaire 3	<b><i>What about handwriting? Evidence-Based Statement (EBS) as guidance for decision-making for children with handwriting problems.</i></b> Anneloes Overvelde, Donders Centre for Cognition (Netherlands)
Salle séminaire 4	<b><i>Highlighting activity and participation in the evaluation process of children with DCD</i></b> Batya Engel-Yeger, University of Haifa (Israel)
Salle Paros	<b><i>Demystifying misconceptions about case study research with an example of balance assessment</i></b> Margret Kluwe, Motohide Miyahara, University of Otago (New Zealand)
Salle Samos	<b><i>The development of an intervention program based on both the evidence and what families want!</i></b> Emily Ward, Curtin University (Australia)
Auditoire Jéquier Doge	<b><i>Ghent Developmental Balance Test</i></b> Hilde Van Waelvelde, Ghent University and Arteveldehogeschool University College (Belgium)

#### State of the art

#### Auditoire César-Roux

*Traduction simultanée anglais-français*

Chairwoman: Professor Jane Clark

1:40 - 2:20

#### ***Interdisciplinary guideline in DCD in Germany***

Doctor Rainer Blank, University of Heidelberg (Germany)

2:20 - 3:00

#### ***What can we learn about the brain-behaviour relations from studies in groups of children with brain damage?***

Professor Bouwien Smits-Engelsman, Katholieke Universiteit Leuven (Belgium)

3:00-3:30

Session poster D and E, discussion and coffee break

3:30 - 4:10

#### ***State of the art in performance deficits***

Professor Peter Wilson, College of Science, Engineering & Health RMIT University (Australia)

4:10 - 5:00

#### ***State of the art in intervention and management***

Professor Helene Polatajko, University of Toronto (Canada) and Professor Cheryl Missiuna, McMaster University (Canada)

# Thursday 23 June, Poster Session A

## Epidemiology, Diagnosis and Assessment

### Poster 1

#### Preterm birth: what are the odds of having DCD at school age?

Jill Zwicker<sup>1</sup>, Jessica Edwards<sup>1</sup>, Michelle Berube<sup>1</sup>, Kelcey Erlandson<sup>1</sup>, Stephanie Haug<sup>1</sup>, Heather Johnstone<sup>1</sup>, Meaghan Meagher<sup>1</sup>, Shirley Sarkodee-Adoo<sup>1</sup>

<sup>1</sup>University of British Columbia, Vancouver, Canada

**Background:** Although developmental coordination disorder (DCD) is highly prevalent in children born very preterm or very low birth weight (VLBW: <1500g), the likelihood of these children developing DCD compared to full-term peers is largely unknown.

**Aim:** to systematically review the literature to examine the association of very preterm birth and VLBW with DCD at school-age.

**Methods:** We searched seven electronic databases and retrieved 2159 citations. Studies were selected if they included: (1) school-age children (age 5-18 years), preterm (<37 weeks) and/or VLBW infants; (2) a full-term and/or normal birth weight comparison group; and (3) a measure of motor impairment. Studies were excluded if participants were diagnosed with neurological disorders, infants were small for gestational age, or articles were not published in English. Two independent reviewers screened titles and abstracts, reviewed full-text articles, extracted data, and performed a quality assessment of each article using the Newcastle-Ottawa Quality Assessment Scale. A total of 279 abstracts and 87 full text articles were reviewed, with 16 articles meeting our inclusion criteria.

**Results:** Seven cohort and nine case-control studies were included in our systematic review. All studies showed significantly more children born preterm or VLBW as having a motor impairment consistent with DCD compared to full-term and normal birth weight controls. Seven studies that identified children with DCD using Movement Assessment Battery for Children were entered in to meta-analyses. For children born <1500g and scoring below the 5th percentile, the overall odds ratio was 6.29 (95% CI 4.37 to 9.05,  $p < 0.00001$ ). Using the broader cut-off score of the 15th percentile, the odds ratio increased to 8.66 (95% CI, 3.40 to 22.07,  $p < 0.00001$ ).

**Conclusions:** Children born preterm and VLBW are at significantly greater risk of developing DCD than full-term and normal birth weight peers. Results of this meta-analysis support the need for early identification of DCD and follow-up of the preterm population to school-age.

### Poster 2

#### Development of a screening tool for DCD in preschool children

Brenda Wilson<sup>1,2</sup>, Tanya Rhitman<sup>3</sup>, Shula Parush<sup>3</sup>, Dianne Creighton<sup>1,2</sup>, Stacey Babcock<sup>1</sup>, Bethany Brewin<sup>4</sup>, Melissa Brust<sup>1</sup>, Mitch Clark<sup>5</sup>, Susan Crawford<sup>1</sup>, Ben Gibbard<sup>1,2</sup>, Jennifer Heath<sup>1</sup>, Alice Holub<sup>1</sup>, Kristine Neil<sup>6</sup>, Lisa Semple<sup>5</sup>

<sup>1</sup>Alberta Health Services, Calgary, Canada, <sup>2</sup>University of Calgary, Calgary, Canada, <sup>3</sup>Hebrew University of Jerusalem, Mount Scopus, Jerusalem, Israel, <sup>4</sup>Providence Children's Center, Calgary, Alberta, Canada, <sup>5</sup>Mount Royal University, Calgary, Alberta, Canada, <sup>6</sup>Vision Critical®, Calgary, Alberta, Canada

**Background:** The identification of motor coordination challenges before school-entry may enable monitoring of children's development and the provision of support to ameliorate some of the social and psychological sequelae that often accompany unrecognized Developmental Coordination Disorder (DCD).

**Aims:** The purpose of these two studies is to develop a parent questionnaire to identify DCD amongst preschoolers (3-4 yrs) and to assess its reliability and validity.

**Method:** Items were generated in Israel and their suitability and relevance assessed by expert opinion. Parents of 146 children in that country, both typically developing (n=91) and referred for developmental

delay (n=55), completed the questionnaire (28 parents twice over two-week interval). A second study is now underway in Canada with an English version of the 'Little DCDQ'. A sample of 300 children (130 non-motor-impaired and 170 motor-impaired) will allow further examination of the reliability and will establish cut-off scores to indicate risk for DCD (taking into account the effects of sex, age, attention and social problems). The Movement Assessment Battery for Children-2 and Beery-Buktenica Test of Visual Motor Integration will be administered and used to assess its concurrent and predictive validity.

**Results:** In the initial study, test-retest reliability ( $r=0.84$ ;  $p<0.001$ ) and internal consistency ( $\text{Alpha}=0.931$ ) were high. Construct validity was evidenced by significant differences between the typical and referred groups ( $t[144]=10.23$ ;  $p<0.001$ ). No age-group differences were found. In the second larger study, use of standardized testing to define motor impairment may provide stronger evidence of validity and will enable the development of cutoff scores.

**Conclusions:** The development of a preschool parent questionnaire for DCD has important clinical implications for the provision of adequate services for children.

### *Poster 3*

#### **The prevalence of DCD in Brazil**

Nadia Valentini<sup>1,2</sup>, Jane Clark<sup>1</sup>, Jill Whittall<sup>1</sup>, Monia Coutinho<sup>2</sup>, Bárbara Spessato<sup>2</sup>

<sup>1</sup>University of Maryland at College Park, United States, <sup>2</sup>Universidade Federal do Rio Grande do Sul, Columbia

**Background:** The identification of children at risk as well as those with Developmental Coordination Disorder (DCD) is important. While prevalence data are available for many populations (e.g. UK, Sweden), there are no data for Brazil.

**AIM:** The purpose of this study was to estimate the prevalence of DCD in Brazil.

**Methods:** The MABC was used to assess 949 children ages 4 to 10 years.

**Results:** The prevalence of children identified as having DCD (i.e., at or below the 5th %ile) was 17.6% and 14.2% were classified as at risk for DCD (6th -15th %ile). Examination of the prevalence of DCD by the age bands (AB) indicated the highest ( $p<.05$ ) prevalence for the 9-10-year-olds (AB3) (AB1 =11.8 %; AB2 =12.9%; AB3 23.9%). To better understand where the difficulties occurred, we examined the items within and between the age bands. Children demonstrated more difficulties in dexterity and ball skills compared to balance ( $p<0.001$ ). AB1 children showed more difficulty with balance ( $p<.001$ ) and similar performance at dexterity and ball skills ( $p=.30$  and  $p=.07$ ) compared to AB2. AB3 children showed inferior performance in dexterity, ball and balance compared to AB1 and AB2 ( $p .05$  to  $.0001$ ).

**Conclusion:** DCD prevalence and at risk cases were much higher than found in other countries and may be due to restricted opportunities for practicing motor skills. The study highlights the need to determine whether the present results are influenced by cultural skill promotion policies or by methodological factors.

### *Poster 4*

#### **The Assessment of Motor Coordination and Dexterity (AMCD): motor development in Brazilian school age children from higher and lower socioeconomic status**

Ana Amelia Cardoso<sup>1</sup>, Livia C. Magalhães<sup>2</sup>, Márcia B. Rezende<sup>2</sup>

<sup>1</sup>Federal University of Parana, Curitiba, Brazil, <sup>2</sup>Federal University of Minas Gerais

**Introduction:** Children with Developmental Coordination Disorder (DCD) present motor coordination difficulties that interfere with activities of daily living and/or academic performance. There is no valid and reliable motor assessment tool standardized for the Brazilian children. The Assessment of Motor Coordination and Dexterity (AMCD) is being created as a standardized measure to assess motor coordination in Brazilian children ages four to eight years old.

**Objectives:** To examine the sensitivity of the AMCD to identify children with DCD, to examine its concurrent validity and to verify the feasibility and clinical usefulness of the instrument.

**Methods:** 181 seven and eight years-old Brazilian children from public and private elementary schools,



representing low and high socioeconomic levels, respectively, were recruited to participate in the study. The Developmental Coordination Disorder Questionnaire (DCDQ-Brazil) was used to screen children with probable DCD and typically developing peers. The participants were evaluated with the AMCD and the Movement Assessment Battery for Children (MABC-2). Concurrent and predictive validity will be calculated.

**Results:** Considering MABC-2's 5th percentile, the frequency of DCD was 17,7% (32 children), with similarity between public and private schools. Combining the DCDQ-Brazil and the MABC-2 as diagnostic criteria, several AMCD items (among 39 items) didn't show significant differences between DCD and typically developing children. Some AMCD items seem to be less discriminative for children in private schools.

**Conclusion:** The creation of the AMCD represents an effort to develop a standardized motor assessment tool to be used by clinicians and professionals working with children in the school system. Without proper assessment tools it is difficult to identify children in need for support or intervention. The results suggest that the AMCD has potential, but some items should be revised or excluded and that it may be necessary to create different criteria for children in public and private schools.

### *Poster 5*

#### **Identification of children with DCD in Brazil: the performance of 7 and 8-years old Brazilian children on the MABC-2**

Ana Amelia Cardoso<sup>1</sup>, Livia C. Magalhães<sup>2</sup>, Márcia B. Rezende<sup>2</sup>

<sup>1</sup>Federal University of Parana, Curitiba, Brazil, <sup>2</sup>Federal University of Minas Gerais

**Introduction:** In several countries children with Developmental Coordination Disorder (DCD) are diagnosed and receive special attention. In Brazil, however, the identification of these children is difficult because no motor coordination assessment has been standardized for the Brazilian children.

**Objectives:** To examine the performance of seven and eight years old Brazilian children on the Movement Assessment Battery for Children ? 2nd edition (MABC-2) and to compare the performance of DCD and typically developing children.

**Methods:** 181 seven and eight years-old Brazilian children from public and private elementary schools were recruited to participate in the study. The Developmental Coordination Disorder Questionnaire (DCDQ-Brazil) was used to screen typically developing and children with probable DCD. The participants were evaluated with MABC-2. The performance of children from public and private schools, representing low and high income families, was compared using the Mann-Whitney test.

**Results:** The MABC-2 identified significant differences in motor performance between seven and eight years old children, but no differences were found regarding public and private schools. Considering the seven-years-old children from public schools, three MABC items didn't show statistical difference between the DCD and typically developing groups. For the seven-years-old children from private schools, two items didn't show statistical difference between groups. Considering the eight-years-old children from public schools, two items didn't show statistical difference between groups and for the 8-years-old children from private schools, three items didn't show statistical difference between groups.

**Conclusion:** Age but not socioeconomic status influenced the performance on the MABC-2, but several test's items did not seem to discriminate differences in motor performance between DCD and typically developing Brazilian children ages seven and eight years old. The MABC-2 is not standardized for the Brazilian children, and the results suggests that it is necessary to conduct further validation studies before using the MABC-2 to identify motor coordination problems in Brazilian children.



## Poster 6

### The development of the Taiwanese Movement Assessment Test for children

Yao-Chuen Li<sup>1</sup>, Sheng K. Wu<sup>2</sup>, Tung-Chou Li<sup>1</sup>

<sup>1</sup>Department of Physical Medicine and Rehabilitation, Cathay General Hospital, Taipei, Taiwan, <sup>2</sup>Institute of Sport Performance, National Taiwan College of Physical Education, Taiwan

**Background:** It is recommended that an individually administered test with a culturally-appropriate norm should be used to meet Criterion A of DSM-IV-TR for DCD. Nevertheless, there was not any instrument designed to assess motor proficiency of school-age children in Taiwan or Asia.

**Aims:** The purpose was to develop the Taiwanese Movement Assessment Test for Children (TMA) with an age- and gender-matched norm to identify children with DCD.

**Method:** The developing process included discussion, revision and establishment stages. At the discussion stage, several Delphi panels were held to confirm administration criteria and preliminarily select 15 of 18 testing items to evaluate children. 112 children were evaluated at the revision stage, and then 5 items were eliminated due to poor discrimination or prediction ability. Eventually, the TMA test consisting of 10 testing items was identified. In addition, 719 boys and 646 girls aged 9 to 12 years participated in this study to develop the norm, and the data of TMA test were further analysed to establish the validity and reliability based upon the results of the MABC test as the golden standard.

**Results:** The Cronbach's alpha coefficients were 0.727-0.747 indicating a strong internal consistency, and the ICC values of test-retest reliability were 0.404-0.888. Using factor analysis, four dimensions: Ball Control, Visual Motor Integration, Fine Motor and Balance Control were defined. Using the MABC test as the golden standard, the concurrent validity of the TMA test for children with DCD was that the discrimination ability was 82.7%, and that sensitivity and specificity were 0.75 and 0.623, respectively.

**Conclusion:** The TMA test with a Taiwanese norm reveals objective reliability and validity. We strongly suggest that it should be widely applied to assess motor coordination of children and diagnose children with DCD in Taiwan.

## Poster 7

### Rasch analysis of the Taiwanese Movement Assessment Test for Children

Hsu Chi-Yang<sup>1</sup>, Wu ShengK.<sup>2</sup>, Shih Ching-Lin<sup>3</sup>, Zhu Yi-Ching<sup>4</sup>

<sup>1</sup>Cheng Ching Hospital, Taichung, Taiwan, <sup>2</sup>Institute of Sport Performance, National Taiwan College of Physical Education, Taichung, Taiwan, <sup>3</sup>Center for Teacher Education, National Sun Yat-Sen University, Kaohsiung, Taiwan, <sup>4</sup>Department of Physical Therapy, Graduate Institute of Rehabilitation Science, China Medical University, Taichung, Taiwan

**Background:** The Taiwanese Movement Assessment (TMA) Test for Children was recently developed to assess motor coordination and to diagnose children with DCD in Taiwan. Rasch methodology can be used to model the relationship between item difficulty, person ability, and the probability of a given response.

**Aims:** To examine scale properties of the TMA test using Rasch analysis.

**Method:** A total of 2058 children (1095 boys and 963 girls) aged nine to twelve years were recruited from 17 elementary and junior high schools across Taiwan. The TMA test includes ten items and five items contain the tests of the preferred side and non-preferred side. In total, 15 items of the TMA test were analyzed using software ConstructMAP with partial credit model.

**Results:** The Cronbach's alpha coefficients of the TMA test were 0.80 indicating a strong internal consistency. The infit and outfit mean square standardized residual (MNSQ) scores of 15 items fell inside an acceptable range of 0.78 to 1.17, denoting that the actual response on TMA test fit the Rasch model's expectation pretty well. Six items (cock trail, overarm throwing and catching with dominant hand, one-leg standing with dominant & non-dominant leg, zig-zag hopping with dominant & non-dominant leg) exhibited disordering of the step difficulty indicating that the response scale may not be efficient to differentiate performance of participants with different levels of motor ability. "One-hand catching with non-preferred hand" is the most difficult item and "throwing beanbag" is the easiest item. Three items (throwing beanbag, one-leg standing with dominant & non-dominant leg) showed

differential item functioning (DIF) for genders. Boys had more difficulty with these items when compared to girls.

**Conclusion:** All items of the TMA test fitted the Rasch model's expectations. The scoring categories in a few items may need to be modified to achieve suitable scoring categories.

### *Poster 8*

#### **Analysis of subgroups of children with DCD in Taiwan- the use of Taiwanese Movement Assessment Test**

Tai-Fen Song<sup>1</sup>, Sheng K Wu<sup>1</sup>, Yi-Ching Zhu<sup>2</sup>, Yao-Chuen Li<sup>3</sup>

<sup>1</sup>National Taiwan College of Physical Education, Taichung, Taiwan, <sup>2</sup>China Medical University, Taichung, Taiwan, <sup>3</sup>Cathay General Hospital, Taipei, Taiwan

**Background:** Previous studies were in agreement on the heterogeneity of children with developmental coordination disorder (DCD). Hence, it is essential to classify DCD children based upon their motor characteristics prior to applying an appropriate training program. However, there was no any research adopting an evaluation tool with a Taiwanese norm to examine the subtypes of children with DCD.

**Aims:** The purpose was to use the Taiwan Movement Assessment Test for Children (TMA test) to classify children with DCD and identify the subtypes.

**Method:** At the first stage, the Movement Assessment Battery for Children (MABC) test with a Taiwan norm was used to evaluate 2059 students aged 9-12 years old. In total, 109 children were identified as DCD. At the next stage, we used ten items of the TMA test as variables for K-means cluster analysis to classify children with DCD. One-way ANOVA was also used to examine the difference of motor characters of subtypes.

**Results:** Cluster profiles for four subtypes of DCD children were identified. Subtype I performed worse in fine motor skill. Subtype II, which was the most impaired group, displayed deficits in general motor coordination ability. Subtype III displayed least deficits in all movement items and were good in fine motor skill. Subtype IV experienced difficulties in the balance ability. **Conclusion:** Developing the subtypes will provide us with a better understanding toward movement difficulties and motor behaviors of children with DCD in depth. This systematic classification could be used to design efficient and appropriate interventions for those children concerning their specific deficits of motor abilities in the future.

### *Poster 9*

#### **Psychometric properties of the Movement Assessment Battery for children'2 in Greek population**

Theodoros Ellinoudis<sup>1</sup>, Thomas Kourtessis<sup>2</sup>, Christina Evaggelinou<sup>1</sup>, Zoe Konstantinidou<sup>1</sup>, Antonis Kambas<sup>2</sup>

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**Background:** The second edition of Movement Assessment Battery for children (MABC-2, Henderson, Sugden, & Barnett, 2007) is a revision of the MABC test. Changes undertaken to produce the second edition involved revising existing items and introducing some new ones.

**Aim:** The aim of this study was to examine specific aspects of the reliability and validity of Age Band 1 (AB1) of the Movement Assessment Battery for Children-second edition (MABC-2) in Greek preschool children.

**Method:** One hundred and eighty-three children 36-64 months old (M=50 months, SD=9 months) participated in the study. Test-retest reliability of the MABC-2 was evaluated using Intraclass Correlation Coefficients (ICC). Regarding internal consistency, Cronbach's Alpha for the items of each motor domain was estimated. Confirmatory factor analysis was employed to examine the factorial validity of the MABC-2 test. To further examine the validity, correlation coefficients among the items score and the total score were also calculated.

**Results:** The ICC for all test items was good, except for 'drawing trail' task, which was moderate.

Cronbach's Alpha coefficient values were .51, .70 and .66 for Manual Dexterity, Aiming and Catching, and Balance respectively. In the confirmatory factor analysis, Goodness of fit indices suggested a satisfactory fit of the data to the model. Correlation coefficients between each test item and the total score were moderate.

**Conclusion:** Results suggested that MABC-2 can be a reliable and valid tool for the assessment of movement difficulties among children 3-5 years old.

#### *Poster 10*

##### **MABC-2 Test and Checklist applied to Italian children with and without DCD**

Stefania Zoia<sup>1</sup>, Marina Biancotto<sup>1</sup>, Giovanna Pelamatti<sup>2</sup>, Michela Borean<sup>1</sup>, Laura Bravar<sup>1</sup>, Aldo Skabar<sup>1</sup>, Marco Carrozzini<sup>1</sup>

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**Background:** Valid, reliable and standardized Italian tests are not available to assess Developmental Coordination Disorders (DCD). The Movement Assessment Battery for Children-2 (MABC-2) is recommended in the diagnostic guidelines for DCD, although its clinical value is not well documented.

**Aims:** The study verified the usefulness of the MABC-2 Test in an Italian sample. Data were also collected using the MABC-2 parents/teachers Checklist regarding daily living activities to verify the credibility of parents/teachers reports, compared to the original norms.

**Method:** Children between 5 to 12 years comprised our sample of 100 Italian typically developing children and 70 children with a diagnosis of DCD according to DSM-IV-TR criteria. All children performed the 8 tasks of the MABC-2, obtaining a total score and three component subscores: manual dexterity, aiming-catching and balance. In addition, parents or teachers completed the MABC-2 Checklist for each child.

**Results:** Italian children scored higher than the U.K. children in all tasks. Children with DCD always performed worse than both Italian and English children, but about 6% of the clinical group reached only a risk level for DCD. Parents' Checklist results showed a significant correlation with the MABC-2 scores of children with DCD, while 50% of typically developing peers were also referred at risk or with significant movement difficulties.

**Conclusion:** Results show that the MABC-2 Test and Checklist are suitable for the Italian population too. The MABC-2 tasks maintain their ecological features, nevertheless, data from both sample groups underline the need for national norms. Furthermore, single clinical profiles revealed that a severe drop in one of the three MABC-2 component scores (e.g., manual dexterity) is sufficient to determine a total score at or below the 5th percentile. This needs deep examination, since a similar result infers a diagnosis of DCD.

#### *Poster 11*

##### **Concurrent validity of the balance subscore of M-ABC-2 and PDMS-2 and the Ghent Developmental Balance Test**

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**Background:** Various developmental motor disorders cause poor balance, resulting in difficulties with several functional tasks involved in activities of daily living. M-ABC-2 has been developed to offer a total score to identify children with developmental coordination disorders. But is the balance subscore of M-ABC-2 valid to be used to judge the balance abilities of a toddler? PDMS-2 offers a 'stationary' subscore based on several static balance items mixed with some force and praxis items. The recently developed Ghent Developmental Balance Test (GDBT) aims specific to evaluate balance. GDBT proved already to be a reliable instrument and correlates good with age.

**Aims:** To evaluate in 3 to 5 year old children the concurrent validity of the balance subtest of M-ABC-2

and the stationary subtest of PDMS-2 by comparing the test results to the GDBT.

**Participants:** Thirty 3 to 5 year old children from regular schools. Teachers were asked to identify in their class group two children with rather poor motor skills, but without a known medical condition.

**Method:** M-ABC-2 contains 3 balance items. PDMS-2 and GDBT use a section of a developmental series of respectively 30 and 35 items to evaluate a child. Children were assessed with M-ABC-2, PDMS-2 and GDBT on the same occasion, in a random sequence. Raw data from the 3 M-ABC items were used to create a ranking of the children. The sum of these rankings was used as balance subscore of the M-ABC. Spearman correlation coefficients are calculated between the raw results of the tests.

**Results:** Correlation coefficients of 0.80 between M-ABC-2 and GDBT, 0.90 between PDMS-2 and GET and of 0.83 between M-ABC-2 and PDMS-2 were calculated.

**Conclusion:** M-ABC-2, PDMS-2 and GDBT measure a similar concept. Further research is necessary to evaluate the validity of the tests to identify children with balance deficits.

## Poster 12

### Could it be possible that crossing the border makes your diagnosis change? Calibrating the Movement Assessment Battery for Children-2 for use in different countries

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**Background:** The Movement Assessment Battery for Children is revised (Movement ABC-2; Barnett, Henderson & Sugden, 2007). In the Netherlands, a score on the Movement ABC-2 Test at or below the 15TH percentile is used as one of the diagnostic criteria for Developmental Coordination Disorder. Therefore, norms should be valid.

**Method:** A representative sample of Dutch and Flemish children is tested with the revised Movement ABC-2. The stop-procedure for second trials as suggested in the manual was not used so that scores were not biased by the continuation rules and therefore comparable to the UK data collection procedure. Means, SD and percentiles scores of this sample of children were compared to the scores of the UK samples. Second, p5 and p15 percentile were determined and standards scores per cluster and total score were examined.

**Results:** Specific items scores deviated from the UK reference values suggesting necessary adjustments for the applicability of the norm-referenced scores of the Movement ABC-2 for other countries, like the Netherlands and Flanders. Except for very young children, the Dutch-speaking sample scored better than the UK reference groups. Importantly the 5th and 15th cut deviates strongly for the UK sample. For instance of for Age band 2 the 15th percentiles lie at 8, 8, 8, 9 for Manual dexterity, Aiming and catching, Balance and Total score respectively. For the 5th percentile these values are 6,7,6,7.

**Conclusion:** For diagnostic use researchers and clinicians should use the reference norms that have been validated for the group of children that they are applied to. The results indicate that there possibly is a cultural influence on the age norms of the Movement ABC-2. It is important to discuss different external ways of to validate cut off values for motor impairment, besides statistically defined points based on means and standard deviations in a random sample.

## Poster 13

### Standardization of a tool for identifying children with motor problems

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**Background:** Motor problems are often described as clumsiness or poor motor coordination and influence the everyday practical tasks that the child has to perform. Motor competence not only allows children to carry out tasks such as dressing, feeding and bathing, but it also affects their self esteem

and how they are viewed in the presence of their peer group. If clumsiness in preschool children is a precursor to academic performance in school then it is important to identify the motor problems early in order to intervene effectively.

**Aims:** To examine reliability and validity of the "Zuk Assessment" for identification and diagnosis of motor problems and clumsiness and determine its standardized scores in an Israeli population aged 5-6 years.

**Methods:** 156 children (78 males, 78 females; mean age  $5.47 \pm 0.37$  years) recruited from 13 kindergartens of typically developing children were evaluated with the Zuk Assessment. Intra-rater and inter-rater reliability were examined on 2 samples of 15 and 13 children respectively. **Results:** Reliability was indicated by high ICC scores both in intra-rater (ICC=0.89) and inter-rater (ICC=0.95) paradigms. Face validity was verified by three specialist pediatric therapists experienced with clumsy children. The total Zuk score had a normal distribution similar to that found in the literature and identified 5.1 % (-2SD) and 12% (between -1SD to -2SD) of children with motor-related problems.

**Conclusions:** This test is clinically valid and reliable and standardized for evaluation of motor problems and clumsiness in an Israeli population.

#### *Poster 14*

### **Psychometric Properties of the Japanese version of the Developmental Coordination Disorder Questionnaire 2007 (DCDQ'07)**

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**Background & Purpose:** Developmental Coordination Disorder (DCD) is a common childhood condition; its prevalence is estimated to be between 5 to 9 percent of school children worldwide. Although English questionnaires are available, there are no instruments to identify DCD in Japan and therefore no available information on its prevalence in Japan. We developed a Japanese version of the Developmental Coordination Disorder Questionnaire 2007 (DCDQ '07) following the recommended process for cross-cultural adaptation of instruments (i.e., translation, back-translation and analysis by an expert committee). There is no identical idiom "bull in a china shop" in Japan, we changed that phrase into more familiar words with examples to make it easy to be understood by Japanese parents, especially by young generations.

**Method:** We conducted the school-based nation-wide study with the Japanese version of the DCDQ, with children aged 6 to 15 years, (n= 25,779).

**Results:** Cronbach's alpha for the full scale of a Japanese version of the DCDQ was 0.922. Each of the subscales showed similarly high internal reliabilities. ICC coefficients were high, ranging from 0.914 to 0.922 for all 15 of the items. Factor analysis with varimax rotation showed 3-factor model which were identical to the original DCDQ '07.

**Conclusions:** We have found that the Japanese version of the DCDQ, which we developed, has sufficient reliability. With further research, it may prove that the Japanese version of the DCDQ could be a useful screening instrument to identify and assess motor coordination difficulties of children in Japan. This would enable the cross-cultural and international comparisons of DCD.

**Acknowledgement:** This study was supported, in part, by Grant-in-Aid for Scientific Research from the Japan Society for the Promotion of Science, and Research Grant from the Ministry of Health, Labour and Welfare, Japan.

## Poster 15

### Age-related changes in scores of the Japanese version of the Developmental Coordination Disorder Questionnaire in community-based children

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**Background:** The Developmental Coordination Disorder Questionnaire (DCDQ; Wilson et al., 2007) is a parent questionnaire developed for the identification of functional motor problems in children. Recently, a Japanese version of the DCDQ has been developed in accordance with the current guidelines for cross-cultural translation of psychometric instruments (Nakai et al., 2010).

**Aims:** The purpose of this study was to examine the effects of gender and chronological age on the total and sub scores of the Japanese version of the DCDQ (Nakai et al., 2010).

**Methods:** We administered the Japanese version of the DCDQ to a total of 7,535 parents or care-givers of children who went to public day care centers, primary, or intermediate schools in a city in Aichi Prefecture, located in the central part of Japan. Of these 6,330 completed questionnaires (84%) were returned. Ninety-four percent of the respondents were mothers, five percent were father, and the rest were grandparents.

**Results:** Two-way (gender X grade) ANOVA were performed on the total and sub scores of the DCDQ. On the subscales of Control During Movement and Fine Motor, the scores linearly increased with the advancement of the children's grades. The increase trend of the General Coordination subscale was more pronounced than the other subscales. No significant gender effect was observed.

**Conclusion:** The age trend of the Japanese version of the DCDQ revealed in this study will serve as bases for future developmental research into motor coordination and for screening developmental coordination disorder in different age groups in Japan.

## Poster 16

### Descriptive analysis of the Developmental Coordination Disorder Questionnaire (DCDQ'07) in a population-based sample of children with and without DCD

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**Background:** Widely used as a screening tool for both research and clinical purposes, the Developmental Coordination Disorder Questionnaire (DCDQ) (Wilson et al., 2000) discriminates children with developmental coordination disorder (DCD) from their typically developing peers. Recently, the DCDQ has been revised as the DCDQ'07, which contains 15 items and includes an expanded age range from 5 to 15 years (Wilson et al., 2009). In the research literature, studies report the use of the DCDQ/DCDQ'07 with samples drawn primarily from clinical settings. To date, the characteristics of the DCDQ'07 when used in a large, non-clinical sample have not yet been examined.

**Aim:** The purpose of this study is to examine the distribution of DCDQ'07 total scores: 1) in a large, non-clinical sample of children aged 8-15 years, and 2) in a sub-sample of children who met diagnostic criteria for DCD, according to DSM-IV criteria.

**Method:** This is a secondary analysis of data collected as part of a larger study conducted in two public school boards in Ontario, Canada, that screened 3151 school-aged children (1590 boys, 1561 girls) for motor coordination difficulties. This study includes a sample of 3084 children aged 8-15 years (mean age 11.7 yrs; SD:1.5) and a sub-sample of 122 children who met diagnostic criteria for DCD (mean age: 11.4 yrs; SD:1.5). Descriptive statistics for the distributions of DCDQ'07 total scores for both samples have been analyzed.

**Results and Conclusions:** Parents of 3084 children (97.9% of those who consented to participate) were able to complete the DCDQ'07 questionnaire independently. DCDQ'07 total score distributions for

both the total sample and DCD sub-sample, including distributions by age and gender grouping, will be described. Means and standard deviations will be reported. Findings from this study will inform our understanding of the performance of the DCDQ'07 in a population-based setting.

#### *Poster 17*

##### **M-ABC Checklist: task complexity order for Manaus children**

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The MABC test checklist was developed on the assumption that children perform tasks in a contextual setting. It was designed to assess the functional competence of the daily context of children and to be applied by parents, teachers and other professionals concerned with child development. The four sections were ordered according to criterion of increasing complexity in the child-environment interaction: the first two sections involving stable environment, followed by the two that involve unstable environment (Henderson & Sugden, 1992).

The **aim** of this study was to investigate if, in Manaus (Amazonas, Brazil), when completed by classroom (CT) and physical education teachers (PET), the gradual increase of complexity in the child-environment interaction is accompanied by gradual higher scores on sections one to four. Children aged 7 (n = 17) and 8 years (n = 30): 15 CT and 9 PET of eight public schools of Manaus participated. The checklists were filled by means of test and retest.

The **results** indicated a significant difference only between the checklists of CT and PET, in section 3 at the age of 7 years ( $z = -1.963$ ,  $p = .05$ ), and order of sections according to the magnitude of the scores was to ages of 7 and 8 years, respectively: CT ( $2 < 1 = 4 < 3$ ) and PET ( $1 = 2 = 4 < 3$ ) and CT ( $4 < 1 = 2 < 3$ ) and PET ( $1 < 2 < 4 < 3$ ).

In **conclusion**, as expected, CT and PET are similar for the completion of the list despite of their differing work environment. But the supposed complexity order of the sections was not accompanied by gradual higher scores on sections one to four. So regarding the criterion for increasing order of complexity of tasks, the results obtained for Manaus children, did not corroborate those found in the literature.

#### *Poster 18*

##### **Triangulating the Movement ABC-2 Test, Checklist, and the DCDQ: do they converge on the identification and the intervention outcomes of children with DCD**

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**Background:** Standardised assessment tools for DCD do not always seem to agree to each other. This causes problems in making clinical and research decisions.

**Aims:** To illustrate children whose assessment data reveal discrepancies between the DCD criteria of different assessment tools, and to map out the complexity surrounding of assessment and diagnosis of DCD.

**Method:** We taught ten children who met the DSM diagnostic criteria for DSM-IV-TR (American Psychiatric Association, 2000), and assessed them with the performance test and the checklist from the Movement Assessment Battery for Children, 2nd Edition (Henderson, Sugden, & Barnett, 2007) and the Developmental Coordination Disorder Questionnaire 2007 (Wilson, Kaplan, Crawford, & Roberts, 2007) before and after the intervention.

**Results:** Of the ten children, three children exhibited discrepancies between the three assessment tools. Child A improved from the DCD category to the non-DCD category on the MABC Test, but remained in the DCD categories on the MABC Checklist and the DCDQ after the intervention. Child B's categories remained the same within each assessment before and after the intervention. However,



Child B was consistently placed in the non-DCD category on the MABC Test, but constantly classified in the DCD categories on the MABC Checklist and the DCDQ. Child C's performance deteriorated from the non-DCD category to the DCD suspect category after the intervention according to the MABC Test, while the MABC Checklist and the DCDQ consistently placed Child C in the DCD categories before and after the intervention.

**Discussion:** The assessment results of the three children raised questions as to whether or not 1) these children should be diagnosed with DCD; 2) the intervention improved them beyond the cutoff of DCD; 3) further intervention be necessary.

**Conclusion:** Triangulation raised issues of test agreement, local validity, and objective test versus subjective evaluation, thus deepening our understanding of DCD.

### *Poster 19*

#### **Comparison of statistical methods for developing cut-off scores to identify DCD**

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**Background:** The study of Developmental Coordination Disorder (DCD) has been facilitated by the use of common assessments. This involves the translation and cross-cultural adaptation of instruments into other languages, which enables comparisons across populations. The DCD Questionnaire (DCDQ) has been translated into 15 languages, and acceptable reliability and validity of the adapted versions have, in many cases, been established. The method that researchers responsible for the adaptations have used to develop cut-off scores in their countries has varied.

**Aims:** The aim of this presentation is to explore differences in the methods used to establish cut-off scores, and assess the impact this may have on comparison of samples across cultures.

**Method:** Methods used to establish cut-off scores in four countries who have published their studies will be described.

**Results:** In two adaptations, the cut-off scores developed for the original Canadian version of the questionnaire have been applied in that country, followed by testing of the construct validity and the evaluation of sensitivity and specificity in that country. Alternatively, data has been examined to investigate whether there are any differences in the frequency distribution of percentile scores between the original and adapted DCDQ, and sensitivity, specificity, and positive predictive value examined. A third method involved logistic regression analysis and conditional effect plot, with the predicted probabilities of being DCD used to determine whether a child needed further evaluation by standardized motor tests. Compared to the dichotomized grouping in assessing sensitivity and specificity, which provides clinicians with all or none information about a child's probability of being DCD, the informative conditional effect plot could alert clinicians to the child with less conspicuous movement problems.

**Conclusions:** The strengths, limitations and impact of these methods, as well as the use of mean and standard deviation scoring, will be discussed with the audience.

### *Poster 20*

#### **Implications for a Comprehensive Early DCD Assessment**

Jerneja Tercon

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There is an exceptional need in identifying children with DCD in preschool age. Motor coordination problems emerge well before entering school. Assessed with caution and equipped with a comprehensive intervention program, a child with an early DCD assessment would have an outstanding advantage in developing proper strategies for managing daily activities and leading a more fulfilling childhood.

Our research will offer an insight into a range of DCD assessments in early childhood from an

integrative developmental perspective.

First we have the most commonly used Movement ABC-2 (Henderson & Sugden, 2007) which includes assessment of child's motor skills from as early as 3 years of age.

Secondly, a study by Ozbic & Filipcic (2008) indicates a selection of three tasks of gestural imitation by Bergès & Lézine (1972), i.e. tasks for performing gestures by crossing the vertical midline of the body and rotating the hands, for discrimination of younger children at risk of developing DCD and those without the risk.

Furthermore, Zurich Neuromotor Assessment, a test procedure for examining the neuromotor competence of children from the age of 5, enables a quick identification of clumsiness in children among general population.

Another mean of identifying children with a higher risk of DCD is based on the theory of retained primitive reflexes and improper development of postural reflexes after the age of 3,5 years (Blythe & McGlown, 1979, 1998; Goddard Blythe, 2006). Masgutova (2007) also focuses her research on reflexes but from another perspective, as she assesses reflex pattern for evaluation of their level of integration.

Finally, Special Needs Assessment Profile - SNAP (Weedon & Reid 2003; 2005) could also help identifying five year old children at risk of DCD in terms of a comprehensive special educational needs assessment.

### *Poster 21*

#### **Transient dystonia in very low birth preterm children (< 28 weeks of gestation) and its correlation with long-term follow-up**

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**Background:** Approximately 7.5 out of 100 births in Switzerland are premature and 1 % of those are born after less than 28 weeks of gestation and present an uncertain neurological prognosis. Some cerebral complications are easily detected thanks to imaging and their neuromotor outcome is known, other neurological anomalies appear later in spite of a normal MRI. A tonus anomaly called transient dystonia is often found amongst the very low birth preterm children aged at corrected age of 6 to 12 months. The impact and the significance of this anomaly are up to date unknown.

**Aims:** The aim of this study is to measure the incidence of transient dystonia on very low birth preterm children, to define the risk factors and the correlations with tonus anomaly, the MRI exam at term and the middle-term development.

**Methodology:** Retrospective study of very low birth preterm children (less than 28 weeks) hospitalized at the CHUV between 2006-2009 and who have been followed by the Follow-Up Unit (Unité de développement). Gathering of epidemiological data (sex, weight, gestational age, intrauterine underdevelopment, twin birth), clinical data (length of hospitalisation, intubation duration, physiotherapy requirements, anomalies of tone at 6 months, development quotient at 18 months) and US data, plus MRI results (high echogenicity, ADC measures of white matter)

**Results:** This study counts on defining the population of past preterm children with transient dystonia and the risk factors as to permit evaluation of correlation between ADC values of the white matter at term and neurodevelopment at 18 months.

# Friday 24 June, Poster Session B

## Neuroimaging, Perceptual And Motor Skills, Physical Activity

### Poster 22

#### Role of the cerebellum in action planning in children with low motor ability

Carl Gabbard<sup>1</sup>, Priscila Caçola<sup>1</sup>, Tatiana Bobbio<sup>1</sup>

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**Background:** A converging body of evidence hints that the motor deficits in children with DCD are closely tied to problems with mentally representing action, aka, internal modeling deficit. Supporting this hypothesis are reports that children with DCD display lower than typical performance on motor imagery tasks. Motor imagery has been reported to provide a window into the process of action representation and planning (Jeannerod, 2001; Munzert et al., 2009) and plays an important role in the prediction of one's actions. In regard to likely brain structure and processing associations, most frequently mentioned is the parietal cortex followed by the premotor area and prefrontal cortex.

**Aims:** Another structure, one that has not received as much attention and represents the focus of this study, is the cerebellum. Here, we report the results of a study that found a significant association between the ability to use motor imagery and motor ability (more specifically, Balance).

**Method:** The study involved a sample of children aged 7-10 years representing a wide range of motor ability ( $\leq 15\%$  and  $\geq 20\%$ ; percentile rank 2-91) as reflected by the Movement ABC-2. Participants were tested for imagery ability using a simulation of reach task unique with this population.

**Results:** Key findings were that children's overall motor ability and ability to use imagery were positively related,  $r = .39$ ,  $p = .03$ , and when looking specifically at the motor ability subcategories, only Balance was significant in the model, explaining 20% of the variance.

**Conclusion:** Combining this information with empirical evidence and theoretical views from others, we state the case for the role of the cerebellum in action planning. Our conclusion is that cerebellar processing is one of the key factors in the child's ability to mentally represent action and execute movements requiring postural control in the form of balance.

### Poster 23

#### Preliminary analysis of attention and motor preparation in children with DCD: an EEG study

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**Background:** Children with Developmental Coordination Disorder (DCD) often present with dysfunctional motor skills associated with impaired attention and executive functioning. Typical individuals attend to task relevant locations during the preparatory phase of a unimanual movement, while we have shown that DCD adults show an altered pattern of ERP responses when attending to a target in contralateral space. This has not been investigated in a child aged sample.

**Aims:** This study reports preliminary child data using our choice reaction time EEG paradigm recently applied to an adult sample. In this way, we aim to investigate the developmental process of movement and attention modulation in DCD vs. typical individuals.

**Methods:** To date, 10 children with DCD and 7 well-matched typically developing children have completed a go/no go choice reaction time task with concurrent EEG recording. Participants moved the cued effector from the start location to target buttons either in the same hemisphere (ipsilateral condition) or across the body midline (contralateral condition). Measurements included visual enhancement of evoked ERPs to covert visual probes presented at cued hand and target locations.

**Results:** During both movement conditions, the DCD group displayed typical adult attentional trajectories towards cued effect and target location. Intriguingly, a complete reversal of this trend was

seen in the control group.

**Conclusion:** While this is a small sample and therefore a preliminary study, nonetheless, the results present an intriguing paradox, showing a complete reversal of the typical vs. DCD adult pattern of results (with the DCD children displaying a typical form of enhancement at task relevant locations whereas the control children do not exhibit any spatially specific ERP attributes for effector or target location). Potential explanations of these results will be explored including the possibility that DCD children require more spatial information during the preparatory time frame than their peers.

#### *Poster 24*

##### **An event-related potential study on the ventral attention network of DCD under soccer exercise intervention**

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**Background:** Children with DCD showed a deficit of inhibitory control capacity in the ventral attention networks when compared to typically developing (TD) children.

**Aim:** The present study investigated soccer-training-induced changes of event-related potentials (ERPs) in a visuospatial attention orienting task, focusing on the electroencephalographic components regarding early modality specific inhibition (N2) and late general inhibition (P3).

**Methods:** After being screened with the Movement Assessment Battery for Children test, 18 TD children and 28 children with DCD who were then quasi-randomly assigned to either a DCD-training group (n=14) or a DCD non-training group (n=14) were assessed using a visuospatial attention task with centrally non-predictive gaze-directed cues with lower extremities before and after training, while brain event-related potentials were concurrently recorded. The DCD-training group underwent a ten-week soccer training program in a series of 50-minute sessions conducted three times a week with a sequence of increasing complexity.

**Results:** The DCD group showed impaired inhibitory control capacity, smaller P3 amplitude and slower P3 latency as compared to TD children across conditions of the visuospatial attention orienting task before training. After training, beneficial effects emerged with regard to the strength of inhibitory control and the P3 latency in the DCD-training group. **Conclusion:** The execution and acquisition of compound lower-limb motor skills that require attention during extensive soccer training for children with DCD seems to induce reinforced neuronal networks that enable faster cognitive processing, i.e. more efficient stimulus evaluation and classification. The data suggest that the soccer training program used in this work resulted in significant improvement of the ERP and behavioral performance indices for the children with DCD.

#### *Poster 25*

##### **Neural correlates of imitation in DCD: the mirror neuron hypothesis**

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**Background:** Recent findings related to the human mirror neuron system, a fronto-parietal network that is active both during action observation and action execution, have led researchers to posit that this network may be involved in imitation. Clinical tests and research investigations suggest that impaired imitation of actions, postures, and gestures is a key characteristic of DCD.

**Aims:** intend to determine if mirror neuron system dysfunction is a justifiable hypothesis underlying differential imitation ability in DCD.

**Method:** conducted a comprehensive literature review of evidence pertaining to mirror neuron system functioning during action imitation and imitation learning from visual observation. Fifty-six studies

investigating mirror neuron region activation and imitation using neuroimaging and neuropsychological methods were critically appraised for their usefulness in understanding imitation in the context of DCD. In addition, we reviewed research findings of the only 3 fMRI studies known to us providing evidence of the neural correlates of DCD to determine if these brain regions overlap with areas of the mirror neuron system.

**Results:** findings reveal that mirror neuron regions are intricately involved in imitation and that task differences and inter-individual differences correlate with activation levels in this network. Far fewer neuroimaging studies have been conducted in populations with DCD and none of these specifically examined mirror neuron regions of interest or utilized imitation tasks. However, the whole brain analyses in these studies report different activation patterns in key mirror neuron regions (the inferior frontal gyrus and inferior parietal lobule) when compared to control participants.

**Conclusion:** research will need to be conducted using procedures specifically designed to test mirror neuron system involvement during imitation in individuals with DCD. We hypothesize that differential activation will occur in frontal and parietal mirror regions during imitation in individuals with DCD compared to a control population.

### *Poster 26*

#### **Visual scanning performance of children with DCD**

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**Background:** Visual scanning plays an important role in the occupational performance. Studies showed that children with Developmental Coordination Disorder (DCD) have problems in visual perception, however, there were currently little researches focusing on visual scanning in DCD.

**Aims:** This aim of this study was to compare the visual scanning performance of children with DCD to the typically developing children.

**Method:** 26 aged 5-8 years old children participated in this study. According to the score of Movement Assessment Battery for Children-2ed (MABC-2), they were divided into 2 groups All scores in MABC-2 were below 9% in DCD groups and above 9% in typical development (TD) groups. The computerized Teddy Bear Cancellation Test (TBCT) was used. The subjects were asked to cross out all of the targets as fast as possible on the screen. Scanning performance was recorded by the Head Mounted Scene Camera EyeTracker Systems.

**Results:** The results of 5-6 years old children showed that the DCD group had significant more counts of fixation/saccade points and longer total saccade duration than the TD group. However, the results of 7-8 years old children showed that DCD group and TD group showed no significant in all values. The proportion of using organized searching strategy in DCD and TD group is 50% and 93.75%. Children with DCD used significant less organized searching strategy ( $\chi^2=4.774$ ,  $p=.029$ )

**Conclusion:** Compared with TD group, children with DCD showed poor efficiency in visual scanning. They had more fixation /saccade point and longer time to find targets in TBCT, especially for 5-6 years old children. The result supported that children with DCD had visual processing deficit, but this performance was not observed in 7-8 years of children. One of the possible explanations was that children with DCD spent much more time for visual scanning task, such as reading, so they learned better searching strategy and promote their efficiency.

### *Poster 27*

#### **Eye movements of children with DCD**

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**Background:** Children with Developmental Coordination Disorder (DCD) are considered to have problems in visual perception. Oculomotor control is one of the foundation skills of visual perception.

However, there were currently few researches focusing on oculomotor control in DCD.

**Aims:** This study aimed to compare the oculomotor control performance of children with DCD to the performance of typically developing children.

**Method:** Thirteen children with DCD (mean age= 78 month, ranged from 60 to 100) and thirteen typically developing children (mean age = 78 month, ranged from 60 to 100) were recruited. The presence of DCD was determined by a score lower than 10% on the Movement Assessment Battery for Children-2 (MABC-2). The controls scored above 65% on the MABC-2. The experimental tasks included smooth pursuit, saccade, and anti-saccade paradigms. Eye movements were recorded by the Head Mounted Scene Camera EyeTracker Systems.

**Results:** The data of our study revealed that there were no significant differences in all eye movement tasks between DCD and TD groups.

**Conclusion:** There were no significant differences in overall eye oculomotor performance between DCD and TD children. For children with DCD in this study, there was no evidence of a problem in eye movements, which are the foundation skills of visual perception. The limited participants may be the reason for not significant in the result. Further examined the cognitive components of visual perception will be the next focus of our study.

### *Poster 28*

#### **Visual perception of children with DCD**

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**Background:** Many studies have demonstrated that children with Developmental coordination disorder (DCD) display deficits on visual perception, but details of the deficits were not clear.

**Aims:** The aim of this study was to investigate which level of visual perception DCD children display deficits by two tests.

**Method:** The study involved 13 boys with DCD (mean age: 124.2±10.9 months) and 13 age-matched healthy boys (mean age: 131.4±12.7 months). To assess and match the general intellectual development between the DCD and control groups, Raven's coloured progressive matrices test (RCPM) was used.

Difference levels of visual perception were tested with Birmingham Object Recognition Battery (BORB) and Developmental Test of Visual Perception Second Edition (DTVP-2).

**Results:** The score of the RCPM did not differ significantly between the two groups. In the BORB, the score of match tasks (length, size, orientation, position of gap) did not differ significantly between the two groups. In the DTVP-2, the score (eye hand coordination, copying, figure-ground, form constancy) did differed significantly, but the score (position in space, spatial relations, visual closure, visual-motor speed) did not differ significantly between the two groups.

**Conclusion:** Match tasks of the BORB assess low-level aspects of visual perception. DTVP-2 assesses high-level aspects of visual perception. This study supported that DCD children display deficits in high-level aspects of visual perception.

### *Poster 29*

#### **An exploration of visual processing in children with DCD**

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**Background:** Vision is a complex process involving the visuomotor system and the visual system. The main role of the visuomotor system is to orient the eyes to targets of interest so that intake of sensory information can occur; captured visual information can then be used to form a percept, or it can be used to guide action. Few studies have explored how children with DCD use vision to guide their action. In light of their documented difficulties in performing activities requiring eye-hand coordination, closer investigation is warranted

**Aim:** To explore the coordination between eye and hand movements of children with DCD compared to that of typically developing children during well-learned visual-motor tasks.

**Method:** The eye movements of 10 children with and without DCD were monitored during 3 computer tasks: visual attention (look), visual tracking (track), and visual-motor coordination (to land a shuttle on a planet using a computer mouse). Independent sample t-tests were used to explore group differences on eye movements and motor performance measures.

**Results:** In the visual attention task, children with DCD made a greater number of saccades to targets and were found to under/overshoot targets. In the visual tracking task, the eye path of children with DCD was farther away from the targeted path. In the visual-motor task, no differences were found in movement time or distance traveled by the cursor. However, children with DCD made a greater number of saccades and fixations. Eye movement patterns indicated that children with DCD more frequently tracked the shuttle and shifted their gaze back and forth from the shuttle to the planet, while completing the task, suggesting a greater reliance on feedback rather than feedforward control of movement.

**Conclusion:** Tracking of eye movements detected important differences in motor control that were not detected by simple motor performance measures. These findings will inform research investigating eye-hand coordination in children with DCD.

### *Poster 30*

#### **Visuo-motor learning in children and motor ability**

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**Background:** Children with Developmental Coordination Disorder (DCD) struggle with learning typical childhood activities requiring visuo-motor coordination, such as catching a ball, riding a bicycle or writing their name. In fact, difficulty learning to write is their primary reason for referral to health care professionals. A meta-analysis by Wilson & McKenzie (1998) confirmed the difficulties of children with DCD in tasks requiring visuo-motor transformations.

Learning motor-based activities involve a set of complex sensorimotor processes that, when associated with practice, lead to an increased capability for skilled behaviour. While motor control refers to the process of transforming sensory inputs into consequent motor outputs, motor learning can be viewed as the acquisition and mastery of such sensorimotor transformations.

Despite the well-acknowledged difficulties experienced by children with DCD when learning activities requiring visuo-motor transformations, little is known about the relationship between motor ability and learning of a novel, complex visuo-motor task.

**Aim:** The aim of this study was to characterize visuo-motor learning in children with varying motor abilities when learning to perform a task that requires the acquisition of new visuo-motor transformations.

**Methods:** Modelled on a task used by Sailer, Flanagan, & Johansson (2005) with adults, 30 children between the ages of 9-12, of varying motor ability, participated in a computer game, requiring them to land a shuttle (cursor) on a planet (target) using a novel, complex cursor control combining horizontal and rotational hand movements. A series of 50 trials were presented, followed by 10 retention trials.

**Results:** A hierarchical linear model will be fitted to examine whether variation in stages and rates of learning are related to children's motor abilities. Preliminary data analysis suggests that a relationship does exist.

**Conclusion:** Motor learning is the goal of a number of intervention approaches used with children with DCD. A better understanding of the relationship between motor abilities and the acquisition of visuo-motor transformations will inform clinical practice with children with DCD.



### Poster 31

#### Everyday memory in children with DCD

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**Background:** Children with developmental coordination disorder (DCD) have been identified with a deficit in visuospatial organization and it appears that poor visuospatial processing may lead to poor working memory. A number of studies have suggested that children with DCD had general deficits in visuospatial short-term and working memory. To date, however, little is known about everyday memory function of real-life situation in children with DCD.

**Aim:** The aim of this study was to investigate whether children with DCD have everyday memory problems.

**Method:** A total of 13 children with DCD aged 5 to 9 years (mean age 6y 6mo, SD 5mo; 11 males) were included in this study. Everyday memory skills were assessed using the Children's version of the Rivermead Behavioural Memory Test (RBMT-C) and general cognitive function, including verbal and nonverbal ability, were assessed using the Peabody Picture Vocabulary Test (PPVT) and the Test of Nonverbal Intelligence - third edition (TONI-3).

**Results:** Approximately 54 % (7/13) and 46 % (6/13) of participants obtained scores in the 'normal' and 'borderline' range on the RBMT-C total scaled score, respectively. Five of those children who scored in the 'borderline' range were in the aged band 5-6 year, and showed significant difficulties in both verbal and visual memory subtests. Correlation analysis revealed that age and PPVT scores were strongly related with RBMT-C total scaled score for all children with DCD.

**Conclusion:** Findings of this preliminary study indicated that everyday memory of children with DCD were selectively impaired in both verbal and visual domains, especially for younger children. Age and language ability play crucial roles in everyday memory function in children with DCD. The implications of these findings are discussed in light of intervention strategy.

### Poster 32

#### Oromotor functioning and coordination of speech in boys with DCD

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**Background:** Developmental coordination disorder (DCD) is a motor disorder that affects performance, negatively impacting participation in meaningful activities, psychosocial health and well-being. Coordination difficulties may disrupt functioning in essentially every motor domain. Despite an increased prevalence of speech impairments in children with DCD, research on speech production in this population has been limited. A recent study by Ho and Wilmut found differences in movement characteristics when looking at the 2-dimensional movement of external articulators in children with severe coordination difficulties (below 2nd percentile on a motor assessment). These findings suggest that a more comprehensive investigation of oromotor function, including both inner and external articulators in 3-dimensions, of children with DCD is warranted.

**Aims:** The aim of this exploratory study is to characterize movement parameters and overall coordination of speech production in boys 9-12 years of age with and without DCD.

**Methods:** Speech production will be assessed through a series of oromotor activities, including opening and closing the mouth, and uttering various sequences of syllables and words. Using 3-dimensional electromagnetic articulography to generate positional data, various parameters (e.g. timing, velocity, variability, and overall coordination) of speech movements will be characterized. Data will be analysed to determine group differences and interaction effects.

**Results:** Results of this study will provide a comprehensive analysis of speech movements in children

with DCD, relative to typically developing children. A further understanding of oromotor function is essential in understanding DCD and assessing the pervasiveness of the disruption of motor function.

**Conclusion:** This study will characterize movements in speech production in children with DCD, and will inform an understanding of the potentially all-encompassing motor difficulties experienced by this population.

### *Poster 33*

#### **Numeracy and literacy of school beginners are influenced by perceptual-motor development**

Anita Pienaar<sup>1</sup>, Rick Barhorst<sup>1</sup>, Chanelle Kemp<sup>1</sup>, Dane Coetzee<sup>1</sup>

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**Background:** Educational theories support a sensory motor basis for development of intelligence and achievement, and it is indicated that higher levels of thinking and behaviour requires integration among sensory units and motor action. Visual perceptual skills are regarded to be significantly related to math and reading achievement (Sortor, 2003) and arithmetic difficulties and problems in motor components of writing and spatial problem solving activities are also described among awkward children.

**Aims:** To determine whether visual motor integration, visual perception and motor coordination and proficiency have relationships with the numeracy and literacy of grade 1 learners in the North West Province (NWP) of South Africa (SA).

**Method:** Stratified random sampling was used to select 20 schools from 4 school districts in the NWP of SA and 816 grade 1 learners (412 boys; 394 girls, mean age of 6.78 yrs, sd = 0.49) were recruited. Regions and schools were chosen randomly with respect to population density and socio-economic status (Quintile 1= poorest; 5= highest). The VMI-4 (Beery) was used to assess visual-motor integration, visual perception and motor coordination and the BOTMP-SF (Bruininks) to assess motor proficiency. Teachers assessed the numeracy and literacy skills of the learners on a 4-point Lickert scale according to the SA National curriculum guidelines.

**Results:** Significant relationships were found between the standard scores of all 4 assessments and literacy and numeracy. The highest relationships were found between visual motor integration and visual perception and literacy in maths, reading and writing. Visual perception showed the highest correlation with numeracy of the school beginners. Motor proficiency assessed with the BOMTP-SF and with the VMI showed similar significant correlations with all literacy and numeracy aspects.

**Conclusion:** Visual perception, visual motor integration and motor proficiency and school achievement are related and attention should therefore be given to proper perceptual-motor development of young school beginners.

### *Poster 34*

#### **Early and persistent motor delay in Autism Spectrum Disorder: a prospective study of high-risk infants**

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**Background:** Children with autism spectrum disorder (ASD) are commonly identified as having motor difficulties.

**Aim:** To build a profile of motor development in infant siblings of children diagnosed with autism, and to determine whether motor atypicalities are part of the endophenotype of autism.

**Methods:** Participants were 53 infants at high-risk of developing ASD and 50 low-risk infants, tested longitudinally at the ages of 6, 12-15 and 24 months. Outcome measures were the gross and fine motor scales on the Mullen Scales of Early Learning (standardised task) and the Vineland Adaptive Behavior Scales (parental report) at the three age points.

**Results:** High-risk and low-risk groups differed significantly on motor scales on both tests at 6 months,

but did not differ significantly on visual reception at this age. Strong correlations were found particularly between measures of gross motor ability across the scales at all three age points. In addition, gross motor ability at 6 months was a good predictor of gross motor functioning at 12 and 24 months in both groups in parental report and standardized tests. Fine motor ability at 6 months was only a good predictor of later fine motor functioning in the high-risk group. Although the pattern of significance changed slightly with age, the high-risk group continued to demonstrate poorer motor abilities at 12 and 24 months across both the Mullen and Vineland scales.

**Conclusions:** Motor atypicalities were found as early as 6 months of age in infants at high-risk of developing ASD, over and above differences in other cognitive areas. These differences between low- and high-risk groups persisted over time. These data suggest that motor difficulties may be part of the endophenotype of autism, and that focused intervention could begin as early as 6 months on the basis of motor markers. These interventions would have important effects not only on motor development, but also on other cognitive and social skills.

### *Poster 35*

#### **Peer victimization and depression in children at risk for DCD**

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**Background:** Children with Developmental Coordination Disorder (DCD) are known to be at risk for secondary social and emotional difficulties, including social isolation. Empirical research exploring the connection between motor coordination difficulties and depression is just beginning to emerge. It is not known to what extent being bullied and victimized by peers may be contributing to these symptoms.

**Aims:** To compare levels of peer victimization and depression in children with and without motor coordination difficulties, and examine the degree to which motor coordination and victimization independently, and jointly, predict depression.

**Method:** Selected from a large, population-based Canadian sample, 159 fifth graders (age 10 years) were identified as being at risk for DCD using the parent-completed Developmental Coordination Disorder Questionnaire and were matched on age and gender to 159 controls. Children's symptoms of depression were assessed using the Behavior Assessment System for Children - Second edition and their experiences with being bullied were elicited using validated questions about verbal, physical, and relational bullying.

**Results:** Children at risk for DCD were more depressed and reported more frequent exposure to verbal and relational victimization than did their peers. The two groups did not differ on exposure to physical victimization. Being at risk for DCD and being bullied more frequently were significant predictors of depression. Being the target of relational bullying was the single most powerful predictor of those examined, accounting for 11% of the unique variance in children's depression scores.

**Conclusions:** This study provides evidence from a large, population-based sample that children who have motor coordination difficulties consistent with DCD are at significantly greater risk for being bullied. Furthermore, being victimized by peers is a factor that significantly predicts depression, above and beyond problems with motor coordination. These findings have clinical and research significance for understanding psychological distress in children with DCD.

### *Poster 36*

#### **Self-efficacy and the physical activity behaviour of children with DCD**

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**Background:** Children with Developmental Coordination Disorder (DCD) are known to participate less in physical activity (PA) compared to typically developing (TD) children. The mechanisms as to why are not yet well understood.

**Aims:** The purpose of this study was to examine the relationship between perceived self-efficacy and PA behaviour in children with DCD and a group of TD children.

**Method:** Children, aged 13 to 15, were selected from a larger prospective cohort examining healthy growth and development in the Niagara Region of Ontario, Canada. Children were assessed for DCD using the Movement Assessment Battery for Children second edition administered by a trained occupational therapist. Those classified as having probable-DCD (pDCD; n=27) were compared to TD children (n=75) on their confidence in completing different intensities and duration of PA (Task Efficacy) and their confidence in completing PA when faced with everyday barriers (Barrier Efficacy). Children first completed questionnaires assessing Task Efficacy and Barrier Efficacy for following 7 days, and then PA was collected longitudinally, over a 7-day period, using accelerometers to measure PA intensity and duration.

**Results:** Children with pDCD were found to have significantly lower Task Efficacy ( $t=-3.33$ ,  $p=0.002$ ) and Barrier Efficacy ( $t=-2.21$ ,  $p=0.029$ ) than their TD peers. They also spent significantly less time doing moderate to vigorous PA ( $t=-2.61$ ,  $p=0.011$ ). It was found that gender modified the relationship between pDCD and PA; males with pDCD spent significantly less time in moderate to vigorous PA when compared to controls. There was no difference in PA behaviour between females with and without pDCD. A multivariate regression analysis showed that Task Efficacy and Barrier Efficacy did not explain the relationship between DCD and PA.

**Conclusion:** Results from this study confirm that children with pDCD have lower Task and Barrier Efficacy scores and also that males have lower PA levels than their TD peers; however these aspects of self-efficacy are not the linking factor between pDCD and PA.

### *Poster 37*

#### **Associations between perceived motor competence, global self worth and physical fitness in children with DCD and healthy controls**

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**Background:** The association between actual motor competence and physical fitness has not much been studied in a clinical referred sample of children with Developmental Coordination Disorder (DCD). Furthermore, it is unknown whether global self worth and perceived motor competence are associated with physical fitness.

**Aims:** To examine differences in physical fitness, perceived motor competence and global self worth between children with DCD and healthy controls. To explore associations between perceived motor competence, global self worth, and actual motor competence and physical fitness.

**Method:** A cross sectional multicentre (n=3) case control study was performed. Participants were children with DCD (n=38, aged 7-12 years) according to all criteria of the DSM-IV, who were treated in a rehabilitation centre for less than 2 months, and typically developing children matched for gender, age and grade. Measures: Physical fitness (Léger 20m shuttle run test, estimated VO<sub>2</sub>max), global self worth and perceived motor competence (CBSK and CBSK-M respectively, Dutch translations of the Harter scales), and actual motor competence (Movement Assessment Battery for Children, Mabc).

**Results:** Significant lower scores on the shuttle run test were found in children with DCD compared to the controls. No differences in perceived motor competence and global self-worth were found between children with DCD and controls. Regression analysis with physical fitness as outcome measure revealed that age and the subscale 'balance' of the Mabc resulted in the best predicting model with an explained variance of 44% ( $R^2=.439$ ). Global self worth and perceived motor competence were no significant predictors of physical fitness.

**Conclusion:** Age and balance were found to predict physical fitness. No associations were found between global self worth/perceived motor competence and physical fitness. Surprisingly, children with

clinically established DCD seem to have comparable scores on global self-worth and perceived motor competence as healthy controls.

### *Poster 38*

#### **Is self-concept in physical education a linking factor between motor and psychosocial problems?**

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**Background:** It is suggested that motor problems are often connected to problems in psychosocial development at various age points. However, the mechanism explaining this association is unknown.

**Aim:** The aim was to study whether self-concept in physical education was a linking factor between self-reported psychosocial problems and self evaluated motor competence in adolescents.

**Method:** The data included 675 adolescents (328 females, 347 males; grades 7-9; mean age 14.2 yrs). Questionnaires were filled out by three youth cohorts in Central Finland. An adolescent version of the Developmental Coordination Disorder Questionnaire was used to classify the sample into high, high average, low average, and low motor competence subgroups. Psychosocial well being was assessed by the Strengths and Difficulties Questionnaire (SDQ). The Self-Concept of Ability in Physical Education (SCPE) consisted of a visual representation of peers in the physical education class against whom the youth had to evaluate their own abilities. The DCDQ

**Results:** The level of motor competence was connected to the level of SCPE indicating that the low motor competence (LMC) group had the lowest SCPE [ANOVA:  $F(3,645) = 50,933$ ,  $p = .000$ ,  $\eta^2 = 0.192$ ]. The motor competence subgroups also differed in all SDQ subscales and the Total Difficulties Scales. However, controlling for the SCPE score revealed that the low SCPE was associated with more emotional symptoms in all motor competence subgroups [ $F(1,646) = 23,25$ ,  $p = .000$ ,  $\eta^2 = 0.035$ ]. Further, The low SCPE was associated with more symptoms in Peer Problems [ $F(3,640) = 3,530$ ,  $p = .015$ ,  $\eta^2 = 0.016$ ] and total amount of Psychosocial Problems [ $F(3,638) = 3,490$ ,  $p = .016$ ,  $\eta^2 = 0.016$ ] in the LMC group.

**Conclusions:** Self-Concept of Ability in Physical Education may be a linking factor between motor and psychosocial problems in adolescents with low motor competence. We found that adolescents with LMC are aware of their poor motor skills, at least in a school setting, and are at risk of psychosocial problems.

### *Poster 39*

#### **Role of physical activity and perceived adequacy on physical education academic performance in children with DCD**

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**Background:** Children with DCD are generally considered to demonstrate challenges in school as a result of fine and gross motor difficulty; especially in Physical Education (PE) class. These children also participate in less physical activity (PA); largely as a result of their perceived inadequacy towards PA. However, little is known as to the magnitude in which participation in PA and perceived adequacy mediates PE academic performance.

**Aim:** The purpose of this study was to determine the mediating role of physical activity and perceived adequacy towards physical activity on academic performance on Physical Education academic performance in children with developmental coordination disorder.

**Methods:** This case-control study involved 61 male and female subjects age 12-13 years with motor impairments and 61 healthy controls matched for age, gender and school location. Subjects were

assessed for motor proficiency and classified as probable developmental coordination disorder (p-DCD) or healthy control using the Movement Assessment Battery for Children, 2nd Edition. Final academic performance grades for Physical Education (PE) were obtained from the District School Board of Niagara with consent from students and their parents. Perceived adequacy towards physical activity was estimated using the Children's Self-perception of Adequacy and Predilection for Physical Activity scale. Physical activity was evaluated using a standardized participation questionnaire.

**Results:** Children with DCD received significantly lower grades in PE ( $72.7 \pm 4.0$ ) compared to controls ( $79.0 \pm 7.2$ ;  $p < 0.000$ ). After adjusting for gender and age, regression analysis demonstrated that perceived adequacy and physical activity significantly mediated (13%) the relationship between DCD and academic performance in PE ( $R^2 = 0.406$ ;  $p < 0.000$ ).

**Conclusions:** These results verify that academic performance in Physical Education is compromised in children with DCD. More importantly, motor impairment leads to lower perceived adequacy and less physical activity, which in turn decreases academic performance in Physical Education

#### *Poster 40*

##### **Constraints to participation in physical activity in teenagers with DCD**

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**Background:** Although children with DCD have difficulties with motor control and coordination, they generally have sufficient capabilities for physical activity. However, results from a range of studies suggest that children with DCD tend to be less physically active than their well coordinated peers (Cairney et al., 2005; Cairney, Hay, Wade, Faught, & Flouris, 2006). They are also less physically fit and more likely to be overweight or obese (Hands & Larkin, 2006), raising concerns for their long-term health and wellbeing.

Qualitative research methods have been used to help understand why individuals do or do not participate in physical activities (Allender, Cowburn, & Foster, 2006) and this information is being used to inform health promotion programs. However little information is available on youngsters with disabilities and to our knowledge there is no work in this area on DCD.

**The aim** of the current study was to understand which factors constrain and facilitate participation in physical activity in children with DCD.

**Method:** Semi-structured interviews were conducted with 8 children with DCD aged 13-16 years and with their parents. Topics covered included attitudes towards physical activity both in and out of school, and factors that constrain or facilitate participation.

**Results and discussion:** Themes emerging from the data relate to individual, environmental and task constraints (Keogh & Sugden, 1985). Practical implications for addressing these constraints and enhancing participation in this group are discussed.

#### *Poster 41*

##### **Prefrontal oxygenation during executive tasks in DCD and ADHD**

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**Background:** More than 50% of children with DCD also have ADHD. Executive dysfunction in ADHD is well-established; however, the relationships between the comorbidity and executive processes have not been heavily investigated. Executive functions are housed in the prefrontal cortex and research on ADHD has shown decreased blood flow to this area while performing executive tasks. The simultaneous measurement of blood flow and performance of executive tasks has not been done in children with DCD. The Tower of Hanoi and the Wisconsin Card Sort Tasks are executive tasks have been shown to rely heavily on prefrontal activity.

**Aims:** The purpose is to better understand executive function and brain activity of children with DCD. Due to the frequent comorbidity of DCD and ADHD and the known executive deficits in ADHD, it is necessary to account for this relationship to improve the understanding of cognitive functioning in DCD.

**Method:** Children between the age of six and twelve with pure DCD and DCD/ADHD will be compared to age-matched typically developing children (TDs). Using near-infrared spectroscopy, a non-invasive form of brain imaging, the change in prefrontal metabolism will be evaluated while children perform tasks of executive function. Set-shifting, working memory and problem-solving will be tested using the Wisconsin Card Sort Task (WCST) and the Tower of Hanoi (TOH).

**Results:** The DCD group is expected to perform the tasks at the same level as TDs, but will exhibit a left lateralized prefrontal hypometabolism. The DCD/ADHD group will also exhibit left hypometabolism, but will exhibit poorer performance than the other two groups on the executive processing tasks.

**Conclusion:** The expected results indicate that children with DCD are performing executive tasks at the same level as TDs despite having ADHD-like left lateralized hypometabolism. They appear to compensate for deficits in brain activity or connectivity by activating unaffected parts of the brain, thereby leaving higher level cognitive processing intact despite coordination-related deficits.



# Friday 24 June, Poster Session C

## Motor Control, Physical Activity

### Poster 42

#### **Leisure time physical activities and associations with aerobic fitness in children with DCD and Typically Developing (TD) children**

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**Aim:** (1) To explore participation in Leisure Time Physical Activities (LTPA) in children with Developmental Coordination Disorder (DCD) recruited at rehabilitation clinics compared with a group of Typically Developing (TD) children; (2) To examine the association between participation in LTPA and aerobic fitness.

**Method:** Thirty-eight children clinically diagnosed with DCD (28 boys, 10 girls; mean age 9 y; range 7 y 2 mo-12 y 1 mo) were age and gender matched with thirty-eight TD children (mean age 8 y 11 mo; range 7 y 2 mo-12 y). Aerobic fitness was estimated using the Maximal Multistage 20-m Shuttle Run Test (MMSRT) and participation in LTPA was self-administered using the Modifiable Activity Questionnaire (MAQ).

**Results:** Children with DCD showed significantly lower scores on Total ( $p=.016$ ), Non-Organized ( $p=.022$ ) and Vigorous LTPA ( $p=.004$ ) compared to TD children. Only 31% of the children with DCD met the health recommendations of performing > 1 hour physical activities compared to 62 % of the TD children. Participation in LTPA was a positive significant predictor ( $b=1.62$  s.e.=0.34 and  $p<.001$ ) of estimated aerobic fitness. The best model including age, condition and Total LTPA explained 45.9 percent of the variance in estimated aerobic fitness. DCD was associated with a significantly lower estimated aerobic fitness.

**Conclusion:** Compared to their healthy peers, Children with DCD spent less time in Total LTPA, Non-Organized and Vigorous LTPA, and have a lower aerobic fitness. Higher participation in LTPA is associated with a higher estimated aerobic fitness.

### Poster 43

#### **Comparison of physical activity of aboriginal, non-aboriginal children, and children with DCD in Taiwan**

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**Background:** The issue of the relationship between motor coordination and physical activity in children population has recently become a popular topic. Nevertheless, limited studies have examined on the issue of aboriginal, non-aboriginal children without developmental coordination disorder (DCD) and children with DCD in Taiwan.

**Aims:** The purpose was to compare and analyze the motor coordination and physical activity of school-aged aboriginal, non-aboriginal children without DCD and children with DCD.

**Method:** 71 children (50 boys and 21 girls) aged 11 to 12 years old were recruited from 7 primary schools. Participants, including 17 aboriginal, 34 non-aboriginal children without DCD and 20 children with DCD, were examined by the Movement Assessment Battery for Children (MABC) test, and then measured and recorded their total physical activities within 7-day by the RT3 accelerometer.

**Results:** Children with DCD scored higher in MABC test than the other two groups. The amounts of total physical activity in 7-day and weekdays were higher in aboriginal group than in non-aboriginal and

DCD groups ( $p < .05$ ). The aboriginal children without DCD had higher physical activities than DCD children in weekend ( $p < .05$ ). The correlation between the MABC score and the total figure of physical activity in 7 days was  $r = -.256$  ( $p < .05$ ).

**Conclusion:** The motor coordination of DCD children was poorer than aboriginal and non-aboriginal children without DCD in three dimensions of MABC test. According to data gathered by RT3, this study confirmed that aboriginal children without DCD participated in more physical activities in the 7-day and weekday periods than DCD children in Taiwan.

#### *Poster 44*

##### **Baroreflex sensitivity is reduced in children with probable DCD**

Nicole Coverdale<sup>1</sup>, Brent Faught<sup>2</sup>, Panagiota Klentrou<sup>2</sup>, Daniele Chirico<sup>2</sup>, John Cairney<sup>3</sup>, John Hay<sup>2</sup>, Deborah O'Leary<sup>2</sup>

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**Background:** Developmental coordination disorder (DCD) is a motor coordination disorder characterized by impairment of fine and gross motor skills leading to challenges with performing activities of daily living. It has been established that children with DCD are less physically active and have increased body fat. This is an important finding since a sedentary lifestyle and increased adiposity are risk factors for cardiovascular disease. The autonomic nervous system plays an important role in heart rate (HR) and blood pressure (BP) regulation. Baroreflex sensitivity (BRS) is a measure of short term BP regulation that is accomplished through changes in HR. Diminished BRS has been shown to be predictive of cardiovascular morbidity and mortality and thus is an important aspect of cardiovascular health.

**Aims:** The aim of this study was to investigate BRS in children aged 13 to 14 years with probable DCD (pDCD) in comparison to children with normal motor coordination.

**Methods:** The Movement Assessment Battery for Children version two (M-ABC2) was used to assess motor coordination. The pDCD group included children who scored at or below the 5th percentile on the M-ABC2. Following 15 minutes of supine rest, five minutes of continuous beat-to-beat BP (Finapres) and R-R interval were recorded (standard ECG). Spectral indices were computed using Fast Fourier Transform and transfer function analysis was used to compute BRS. High frequency and low frequency power spectral areas were set to 0.15-0.4 Hz and 0.04-0.15 Hz, respectively.

**Results:** Children with pDCD ( $n=22$ ) had significantly reduced BRS when compared to controls ( $n=17$ ) ( $p=.049$ ). Additionally, heart rate variability (HRV) indices indicated that total power ( $p=.019$ ) and high frequency power ( $p=.023$ ) were reduced in children with pDCD, indicating that total HRV and parasympathetic activity were diminished in this group.

**Conclusions:** Since reduced BRS and HRV were found in this cohort, the cardiovascular health of this population should be monitored as these autonomic indices are predictive of future cardiovascular morbidity and mortality.

#### *Poster 45*

##### **Developmental delay in finger torque control in children with DCD**

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**Background:** Previous research has shown greater finger force variability in children with DCD as compared to their typically developing (TD) cohorts. However, no study has explored age-related changes in finger force control in this population. This study explored age-related differences in strength and finger torque control in children with and without DCD.

**Aim:** The purpose was to examine potential developmental delays in finger torque control in children with DCD.

**Method:** Thirty-six children with Movement ABC scores at or below the 5th percentile formed the DCD group (age range: 6.8 to 12.6 years); and, 36 TD children (MABC above the 30th percentile) formed the TD group (age range: 6.8 to 12.4 years). The subjects performed two isometric tasks [maximum voluntary torque (MAX) production, and constant torque (CONST) control]. In the MAX task, subjects produced maximum torque for 5s. For the CONST task, subjects continuously maintained a constant torque equal to 40% of his/her maximum for 20s.

**Results and Conclusions:** Analyses indicated that children with DCD compared to TD children: a) have similar levels of strength, b) greater magnitude of variability (i.e. coefficient of variation); c) and lower levels of the structure of force variability (i.e. approximate entropy). In addition, age-based regression analyses revealed that the children with DCD had similar, albeit delayed, developmental trajectories compared to the TD children. This is the first study, to our knowledge, to demonstrate that the developmental trajectory of finger force control is delayed, as opposed to developmentally different, in children with DCD.

#### *Poster 46*

##### **The tapping task in children with motor difficulties**

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The purpose of the present study was to examine the performance of children with movement difficulties (MD) in the externally-paced and self-paced tapping tasks. Thirteen children with MD and 14 typically developing (TD) children (7-10 years) participated in this study. The externally-paced task consisted of producing continuous taps in synchrony with auditory signals, in the following inter signal intervals: 470ms, 1000ms e 1530ms. The self-paced tapping task consisted of producing continuous taps according to the preferred pace of each individual. Participants were required to perform the task with the preferred hand on an electronic drum connected to a computer. The dependent variables of the externally-paced tapping task were absolute error (AE) and standard deviation of absolute error (SDAE). The results of analysis of variance for AE indicated that children with MD are less accurate than TD children, specifically in the intervals of 1000ms and 1530ms [ $F(2, 42) = 3.5, p < 0.05$ ]. Similar pattern of results was found for the SDAE, with children with MD displaying higher variability than TD children in the intervals of 1000ms and 1530ms [ $F(2, 42) = 4.9, p < 0.05$ ]. The dependent variable for self-paced tapping task was the coefficient of variation (CV). The results for the CV showed no significant difference between the two groups,  $t(25) = -0.01, p = 0.99$ . The findings of the present study related to externally-paced tapping task are in agreement with previous research in which children with MD showed difficulties compared with TD children. In addition, in the self-paced tapping task children with MD were capable of performing the task in a consistent mode similarly to their peers. In summary, short timing intervals and preferred pace facilitate to children with MD to perform tapping tasks.

#### *Poster 47*

##### **Effects of internal and external constraints on inter-manual and perceptual-motor couplings in children with and without DCD**

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**Background.** Children with Developmental Coordination Disorder (DCD) experience motor difficulties relative to rhythmic movements and inter-manual coordination. First, the DCD children are characterized by marked impairment in the synchronization of their both fingers, so that the bimanual in-phase tapping mode is less stable compared to control children, hence suggesting a deficit in the internal motor control of bimanual coupling. Second, DCD children present an increase in movement variability when they are required to synchronize their fingers tapping with an external constraint (metronome), suggesting perceptual-motor disorders.

**Aims.** Our aim was to investigate inter-manual and perceptual-motor couplings in a continuous tapping task.

**Method.** Twenty children (10 DCD and 10 control, 7-10 years old) were required to produce the in-phase tapping mode in four conditions. First, the in-phase tapping mode was required with internal constraints: (1) the spontaneous tempo and (2) the maximal speed. Second, the in-phase tapping was required with external constraints: an auditory metronome producing either (3) a tempo near the spontaneous tempo (600 ms) or (4) a slower tempo (800 ms). Four variables were computed: the produced tempo and its variability, the relative phase of the bimanual coordination and its variability.

**Results.** Statistical results indicate that, for all children, the maximal speed condition increases the variability of the bimanual coupling but does not affect the variability of the tempo. Inversely, the external metronome significantly increases the variability of the tempo but does not affect the bimanual coupling. Whatever the conditions, the in-phase tapping was less accurate and more variable in the DCD group but the variability of the tempo was the same in the two groups.

**Conclusions.** Rather than a perceptual-motor coupling deficit, the DCD children seem to present a deficit in bimanual coupling that is not affected by internal and external constraints.

#### *Poster 48*

#### **The effects of task complexity on inter-limb and perception-action coupling in children with DCD**

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**Background:** The ability of inter-limb coordination and perception-action coupling are important to acquire complex movements.

**Aims:** The aims of the study were to examine the effect of task complexity (single task vs. dual task) on the inter-limb coordination and perception-action coupling in children with developmental coordination disorder (DCD) during a gross motor task.

**Method:** Twenty-four children with DCD ( $6.90 \pm 1.16$  years old; 21 boys, 3 girls) and 24 age- and gender-matched typically developing (TD) children participated in the study performing a task of marching or clapping alone (single task) and marching together with clapping (dual task) in three auditory cue conditions (no cue, cue with preferred clap frequency and cue with preferred step frequency). Two Kistler force platforms and a modified custom-made cymbal were used to measure the timing issues of stepping and clapping. The coefficient of variances (CV) of action frequency and step-clap phasing value within-trials were used to examine the performance of inter-limb coordination. The CV of perception-action phasing value was adopted as the indicator of perception-action coupling ability.

**Results:** The CV of action frequency was significantly larger in DCD group than in TD group. The CV of clap frequency was larger in dual task than single task, but the CV of step frequency was not significantly different. The CV of perception-action phasing was smaller in DCD group than in TD group.

**Conclusion:** Children with DCD were more variable than TD children in an action rhythm and inter-limb coordination. And their clapping was more affected when performing a dual task than a single one. However, the action-perception coupling was less variable in children with DCD than in TD children. These results suggest that children with DCD show poor adaptation to a cue and they tend to be entrapped in an attractor status. However, TD children tend to couple their limbs in adaptation and anticipation to the external cue.

## Poster 49

### The intralimb coordination in children with DCD

Min-Jane Hung<sup>1</sup>, Jeng-Fang Yang<sup>1</sup>, Chiung-Yu Cho<sup>1</sup>, Rong-Ju Cherng<sup>1</sup>

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**Background:** The intralimb (inter-segmental) coordination is important for rhythmic movements such as walking. Human joints own redundant degrees of freedom for a certain movement. However, a coordinated movement usually comes from a strategy of constraining excessive degrees of freedom to facilitate control. It is well known that children with developmental coordination disorder (DCD) had poorer motor ability than typically developing (TD) children. However, the differences of the strategy in intralimb coordination between children with DCD and TD children are not clear.

**Aims:** The purpose of this preliminary study was to compare the differences of the intralimb coordination between children with DCD and TD children when performing various rhythmic movements.

**Method:** Six children with DCD and 6 age-matched TD children performed three tasks: walking, consecutive forward jumping and forward hopping. A Qualisys motion capture system was used to collect the kinematic data of the lower limbs. Following the law of the planar covariation, we used the principal component analysis method to analyze the contributions of each segment of lower limb and elevation angle into a planarity configurations and their inter-dependency. The variables were elevation angle, elevation velocity, planarity index (fitness of the task loop) and the shape of the task loop.

**Results:** The results showed that children with DCD had greater variability than TD children in the elevation angle and elevation velocity between trials. They had lower value of planarity index and the shape of the task loop than TD children. The difference of planarity index between children with DCD and TD children was greater in hopping than walking and jumping. And the difference of the ratio was greater in hopping and walking than jumping.

**Conclusion:** Children with DCD have more variable patterns of intralimb coordination than TD children. The differences are bigger when they are performing a more complex task.

## Poster 50

### Online control of handwriting in children with DCD

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**Background:** Previous research indicates that children with DCD present difficulties in forward modeling and online control. Most of these studies emphasize speeded discrete movements, but controlling movements online is imperative for movement sequences of longer duration such as control necessary in handwriting and other daily activities.

**Aim:** The primary purpose of this study is to examine online control of movement sequences that differ in complexity and horizontal space in children with DCD.

**Method:** Children with DCD and typically developing children ages 6 to 10 will perform continuous (loops) and discontinuous (peaks) movement sequences in which complexity will be varied (a series of shapes of the same height or of a combination of heights). The length of the space in which to draw these shapes will also be varied. Kinematic analysis of movement sequences will be performed using NeuroScript and a digitizing tablet.

**Results:** It is expected that children with DCD will present more difficulty in the continuous compared to discontinuous sequences, and in the complex compared to simple sequences, as evidenced by decreased fluency, longer stroke times, and longer pauses between strokes. It is also expected they will exhibit a reduced ability to adjust the sequence to a reduced horizontal space as evidenced by longer duration of strokes and greater variability in the spacing of each stroke.

**Conclusion:** It is expected the results of this study will provide evidence that children with DCD have difficulty updating a motor plan in tasks that require online control even when there is no speeded

component. This research provides initial information that is hoped to ultimately impact remediation of handwriting for children with DCD.

### *Poster 51*

#### **The effect of auditory pacing on period stability and temporal consistency in children with and without co-existing DCD and dyslexia**

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**Background :** In previous research, when compared to typically developing and dyslexic samples, children with co-existing DCD and dyslexia had difficulty organizing and maintaining interlimb coupling ability when asked to pace a dual motor task (clap while stepping) to an external auditory signal. All groups improved over 16 trials of pacing practice. What remains to be determined is how each limb girdle differed in the ability to match the pacing signal.

**Aims:** This study compared period stability and temporal consistency in clap-metronome and step-metronome coupling over 16 trials of a dual motor task .

**Method:** Participants clapped and walked simultaneously with auditory pacing for 4 blocks of practice, 4 trials each block. Three trials for both pre- and post-practice without pacing as baseline and retention. Inter-clapping interval (ICI), inter-heel strike interval (IHI) were used to measure period stability, while coefficient of variation in each blocks (ICI\_CV and IHI\_CV) were used to measure temporal consistency.

**Results:** Significant differences existed between the groups in ICI and IHI, with the TD group differing from both other groups in having a longer period. However, no block differences existed among the 4 practice blocks among the groups, suggesting period stability within the paced trials. No significant differences existed among the blocks and groups; however, all groups had similar trends on decreasing SD over the practice blocks. In the DCD group only, participants lost temporal consistency and returned to pre-practice levels in post-practice trials which auditory pacing was removed. **Conclusion :** The results suggested that the performance of dual motor task in children with co-existing DCD and dyslexia may stabilize to be similar to typically developing children when auditory pacing is available. This effect may last in the lower limbs, but appears to be transitional in the upper limbs girdle.

### *Poster 52*

#### **End-State-Comfort in children with DCD: preliminary findings**

Kate Wilmut

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**Background:** When a skilled adult picks up an object they do it in such a way that their grasp allows them to carry out their intended action. One aspect of this is selecting grasps for end-state-comfort whereby adults begin a movement in an uncomfortable position if it allows them to finish the task in a comfortable position. Previous research has shown that children with DCD at eight years do not differ from typically developing (TD) children in selecting grasps for end-state-comfort (Monteiro e Lima, 2000; Smyth & Mason, 1997). This finding is surprising given evidence that children with DCD show an apparent deficit in the forward anticipation of movement. The lack of apparent differences between groups in end-state-comfort tasks maybe an issue of task difficulty, with previous studies looking at only a single movement. The current study, therefore, extended previous work by considering whether children with DCD are able to select grasps for end-state-comfort in a multiple movement sequence.

**Methods:** Both TD children and children with DCD were asked to grasp a palm sized disc and rotate it so the arrow pointed toward a named colour. Task complexity was increased by increasing the number of movements that were made, from one movement to four movements. Placement of the fingers for each trial were videoed and how far ahead a child planned for end-state-comfort was analysed by considering how each grasp was altered for different rotations.

**Results and Conclusion:** Comparisons between TD children and children with DCD will be made, with a specific focus on how children with DCD cope with an increase in task difficulty. Results will be discussed in terms of how children with DCD forward plan their movements and how this relates to tasks of everyday living.

### *Poster 53*

#### **Ball catching performance between children with and without DCD**

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**Background:** Ball catching is a functional and important occupation which children with developmental coordination disorder (DCD) are worse at.

**Aim:** This study was conducted to investigate the catching performance between children with DCD and typically developing children.

**Methods:** Ten children with DCD (mean age: 6.7 years old, aged 5 to 8) who were dropped below 10th% of MABC-2 and 64 typically developing children (aged 5 to 8 years, 16 of each age) participated in this study. Testing consisted of a sequence of 3 blocks of 10 balls, projected from a three-directional ball machine. We characterized and leveled 3 body component actions (arm, hand, and body, noted as A, H, B) of each two-hand catch, which hypothesized by Haywood and Getchell. Catching performances were also analyzed with a catching scale developed by Wickstrom, and calculated the grasping errors.

**Results:** The data revealed that children with DCD and 5- to 6-year-old controls displayed less advanced modal developmental sequence levels than the older controls (7- and 8-year-old) with respect to the arm and body action components ( $p < .01$ ). Children with DCD and the younger controls also demonstrated less mature catching profiles than the older controls, the catching profiles being A3H3B2 and A4H3B3, respectively. Further analysis showed that the profiles variation were larger in DCD and younger controls than in the older controls ( $p < .01$ ). There were significant differences between DCD and older controls in catching scales and grasping errors ( $p < .01$ ), but not between DCD and younger controls. In addition, there were significant differences over blocks in DCD and 5-year-old controls ( $p < .05$ ) which showed an improvement in catching performances.

**Conclusion:** Compare with 7- to 8-year-old controls, children with DCD displayed immature and unstable catching movement patterns. However, their catching performances were similar to 5- to 6-year-old controls, suggesting that catching performance of children with DCD may not be deficient but rather developmentally delayed.

### *Poster 54*

#### **Preferred patterns for accuracy throwing in school children at risk for DCD**

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**Background:** Emerging motor patterns in children at risk for Developmental Coordination Disorder (DCD) were examined considering dynamical systems concepts.

**Method:** Thirty five primary school children matched by gender, age and observed high (HP) and low motor performances (LP), at risk for DCD, identified by MABC test and DCD-Q took part in this study. The task consisted of throwing a bean-bag into a wooden box. Throwing distances were used as control parameters. The box locations were scaled to the children's height, added by arm lengths for each new distance up to six distances, presented in counterbalanced order. No instructions were given to the children.

**Results:** Mean number of errors increased with throwing distance for both groups. The higher performance group was more accurate and showed greater under-arm throw preference. Children with low performance showed gradual increased in their under-arm throw preference up to the third distance, and at the fourth distance, a sharp increase in choice for under-arm throw followed by increase in



accuracy was observed. This tendency for pattern transition from over- to under-arm throw followed by increased accuracy was also seen in the HP group but between the first and second attempts. Children with LP showed more variability in arm preference, higher preference for no arm-swing, stable across all attempts. Children with HP smoothly increased the amount of arm-swing with distance. Nearly all children preferred to use parallel foot as base of support with no leg swing.

**Conclusion:** The results indicate that throwing distance seems to be a relevant environmental property leading to emergence of throwing patterns. However, in the case of accuracy throwing task goal seems also to be critical for children's choice making for throwing pattern. Children with observed LP showed a different mode of behavioral self-organization. These results have practical implication for motor intervention.

### *Poster 55*

#### **Gait in Children with and without DCD**

Mandy Plumb

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Developmental Coordination Disorder (DCD) occurs in a significant proportion of children, who present with poor sensor motor co-ordination, poor postural control, and show poor acquisition of motor skills. DCD can be defined as a specific problem with coordinative tasks despite normal IQ and no evidence of neurological, biochemical or physical abnormalities (American Psychiatric Association 1994).

This present study examined gait characteristics, muscular activity and co-ordination of body segments during walking in children with and without DCD.

A population of 5 children with DCD (aged 8-16 years) and 5 age matched control children took part in the study. Subjects were required to walk at a self-selected pace along a 15 m walkway in the human movement lab.

Kinematic measures were obtained using a 7-camera VICON MX 3-D motion analysis system (Vicon Motion Systems, Oxford, UK). Surface EMG was time normalized and the mean activity for the both left and right tibialis anterior (TA), quadratus lumborum (QL), and external obliques (EO) was identified.

Gait characteristics indicated walking speed was reduced in children with DCD and cadence increased in children with DCD. Measurements also showed step length was decreased in children with DCD compared to controls, alongside this was an increase in step width.

Kinematic measures revealed increased range of motion in the hip and knee joints and pelvic tilt and pelvic obliquity was also increased in children with DCD throughout the gait cycle. Lumbar spine range of motion was found to be decreased in children with DCD during the gait cycle.

EMG results showed altered muscle timing, with decreased QL and increased TA activity during the gait cycle in children with DCD compared to age matched controls.

These findings indicate children with DCD are taking more steps, walking at a slower speed and to maintain balance exhibit a wider base of support. These data suggest children with DCD have less efficient stability and postural control of the pelvis, hip and knee due to decreased and altered muscle activity during the gait cycle compared to age-matched controls.

### *Poster 56*

#### **Investigating the 'Co-ordination' in DCD: an analysis of the vertical jump**

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**Background:** Developmental Coordination Disorder (DCD) assumes 'coordination' problems, however little data exists on the coordinative behaviors of children with DCD.

**Aim:** To compare the coordination patterns of children with DCD to typically developing (TD) age-

matched peers and adults as they performed a whole-body propulsive action.

**Method:** A 3D motion capture system was used to obtain kinematic data as children and adults performed vertical jumps. In addition to traditional kinematic analyses, principal component analysis (PCA) was used to identify potential jump patterns unique to children with DCD.

**Results:** 2-D PCA identified two principal clusters containing mostly the adults and TD children's jumps. The jump patterns of the children with DCD failed to form a cluster that could be identified as uniquely DCD. Kinematic analyses indicated that the children with DCD demonstrated decreased angular velocities of the hip, knee, and ankle joints at takeoff, despite achieving similar peak velocities as the TD children and the adults. Although the mean differences among the three groups in the relative timing of the peak angular velocities were minimal, the children with DCD demonstrated substantially larger within-subject variability.

**Conclusion:** Children with DCD exhibit different patterns of coordination from their TD peers and adults. Differences in jump performance are not due to reduced velocity of the lower extremity joints. Rather, these children have difficulties consistently co-ordering the segments of the lower extremity with one another. These findings are discussed in the larger contexts of other gross motor coordinative skills and the issues of 'co-ordination' in DCD.

### *Poster 57*

#### **The effect of visual occlusion of the feet on walking patterns of children with and without DCD**

Judith Gentle<sup>1</sup>, Kate Wilmut<sup>1</sup>, Anna Barnett<sup>1</sup>

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**Background:** Research has identified an over-reliance on visual information during walking tasks in children with DCD (Deconinck et al., 2006). The changes seen in walking patterns when visual information is removed may be due to the loss of either optic flow, or visual feedback from the moving limbs/body. Research focusing on hand movements has highlighted a propensity in these children to watch their hand during movement (Wilmut et al., 2006).

**Aim:** The purpose of this study, therefore, was to consider the effect of removing visual feedback from the feet during a walking task in children with and without DCD.

**Methods:** Nine boys aged 11-16 with DCD and nine age-matched controls took part in this study. Participants were asked to walk along a flat pathway for 2 minutes, under three conditions; walking whilst carrying a transparent tray; walking whilst carrying an opaque tray, obscuring vision of the legs and feet; and walking without a tray. Data from video recordings were used to calculate distance travelled, velocity, Froude number, cadence, percentage time spent in double-stance, and stride length.

**Results:** Children with DCD spent longer in double-stance compared to controls. This confirms previous findings that children with DCD have significantly different walking patterns compared to their age peers (Deconinck et al., 2006). Results also indicated that during the tray carrying conditions, the DCD group walked more slowly, took shorter steps, and didn't walk as far as controls. No differences were seen between the transparent and opaque tray conditions.

**Conclusion:** This study failed to provide any evidence to suggest that visual occlusion of the feet affected walking patterns of children with DCD more than controls. However it has illustrated the vulnerability of children with DCD to the additional demands of carrying a tray which significantly affected their walking patterns compared to the controls.

## Poster 58

### Foreperiod duration and motor preparation in children with movement difficulties

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Previous studies have shown that children with movement difficulties (MD) experience difficulty in processing information. Little is known about the effect of foreperiod duration on the response to an imperative stimulus in these children. The aim of this study was to examine the effect of foreperiod duration in children with MD and typically developing (TD) children. Six children (7-8 years) with movement difficulties and the same number of TD children matched by age and gender participated in this study. Participants were required to respond as fast as possible to the illumination of one LED in a set of four by depressing the corresponding button to that illuminated LED, operated by the index and middle fingers of both hands. Both LEDs and buttons were mounted in parallel on separate panels connected to a controlling computer. Participants performed the task in four different foreperiod durations (400, 1000, 2000 and 4000 ms), that is, the time elapsed between the precue information and the imperative stimulus. The main dependent variable was reaction time (RT). The results of a 2 x 4 (Group x Foreperiod) ANOVA indicated that RT was consistently longer in children with MD than in TD children across all conditions [ $F(1,12) = 6.63$ ,  $p < 0,05$ ]. Furthermore, RT was significantly longer in children with MD than in TD children in the 500 ms foreperiod duration compared with other durations [ $F(3,36) = 3.11$ ,  $p < 0,05$ ]. In summary, in movement preparation children with MD are mainly affected by short foreperiod duration whereas TD children are not. These results are discussed taking into account other studies that examined foreperiod duration and precue in movement preparation involving different tasks.

## Poster 59

### Developmental Coordination Disorder versus joint hypermobility: the presence of coordination difficulties at an assessment clinic for children

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**Background:** Developmental Coordination Disorder (DCD) and joint hypermobility have each been associated with poorer participation and quality of life outcomes. Recent paediatric research has further identified the overlapping nature of these conditions. Authors concede that more studies are needed to examine the prevalence and clinical impact of this co-morbidity.

**Aims:** To investigate the reported frequency and functional impact of motor-based difficulties in children presenting to an assessment clinic for biomechanical pain related to joint hypermobility.

**Methods:** Data was collected from children and primary caregivers who attended a tertiary multidisciplinary assessment clinic between 2005 and 2009. Measures included recorded interview responses, range-of-motion testing, and functional assessment tools such as the Childhood Health Assessment Questionnaire (CHAQ). Data was collated and analyses completed using Welch's T-tests for significance.

**Results:** Out of 200 children assessed (40% male, age range 5-16 years), 172 children met criteria for Benign Joint Hypermobility Syndrome. Of these, clumsiness was reported in 50.6%, 46.5% reported coordination difficulties, and 34.9% identified poor ball skills. In addition, 22.7% reported all three issues, indicating that just under a quarter of this group identified compounding motor-based deficits. This is considerably higher than published estimates for the United Kingdom, reporting that 4% of children have moderate coordination difficulties, with 1.8% meeting the criteria for DCD. Those reporting coordination difficulties also presented with higher CHAQ scores ( $p < .001$ ), corresponding with greater functional difficulties in areas of daily living than those without coordination issues.

### Conclusions:

Children presenting with joint hypermobility frequently report motor coordination dysfunction. Those with co-morbidity present with greater impairment in activities of daily living when compared with those

presenting with hypermobility alone. As such, greater consideration is required in relation to how these children and families access services, diagnoses, and appropriate interventions to address all clinical needs and improve overall quality of life.

#### *Poster 60*

##### **Does percent body fat influence performance on MABC-2 Items?**

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**Background:** The Movement Assessment Battery for Children 2nd Edition (MABC-2) is a widely used assessment tool for confirming developmental coordination disorder (DCD). Children with DCD have a greater propensity for physical inactivity that is believed to increased body fat. While a small number of studies have shown a link between body fat and performance on motor tests, overall there is a paucity of data on the subject. To our knowledge, there are no studies that specifically explore the effect of relative body fat on the revised version of the M-ABC.

**Aim:** This study investigated the influence of body fat on each MABC-2 item in 12-14 year old children.

**Methods:** The Physical Health Activity Study Team (PHAST) longitudinal study sampled 124 children (M=72, F=62) with DCD (N=62) and controls (N=62). Motor coordination status was confirmed using the MABC-2. Children who scored at or below the 15th percentile were classified as being probable DCD. Relative body fat was measured using whole body air-displacement plethysmography.

**Results:** Using linear regression analysis, the influence of percent body fat was determined for each of the individual items of the MABC-2 as well as the overall standard scores for balance, manual dexterity and aiming/catching. After controlling for physical activity, increased body fat inversely affected overall balance ( $R^2=0.1575$ ,  $p<0.0001$ ), followed by manual dexterity ( $R^2=0.0923$ ,  $p=0.01$ ), but not on aiming/catching ( $R^2=0.0834$ ,  $p=0.19$ ). With respect to individual MABC-2 items, body fat mostly influenced the balance item; zig-zag hopping ( $R^2=0.1988$ ;  $p<0.0001$ ). Conversely, body fat did not influence the manual dexterity item turning pegs ( $R^2=0.074$ ,  $p=0.41$ ).

**Conclusion:** Our analysis suggests that a significant percent of the variation in MABC-2 scores are influenced by body fat, but not equally for all items. Children with higher levels of body fat are disadvantaged and will generally score lower regardless of any pre-existing coordination deficiency. Consideration for children with excess body fat (ie., overweight and obese) is warranted with administering the MABC-2.

#### *Poster 61*

##### **Participation in physical activity, fitness and risk for obesity in children with DCD: a cross-cultural study**

Nirit Lifshitz<sup>1</sup>, Katz Noomi<sup>2,3</sup>, Naomi Weintraub<sup>3</sup>, Shoshana Steinhart<sup>4</sup>, Shani Raz-Silbiger<sup>3,4</sup>, Sharon A Cermak<sup>5</sup>, Mario Munoz<sup>6</sup>, Aviva Must<sup>7</sup>, Linda Bandini<sup>8</sup>, Carol Curtin<sup>8</sup>, James Gleason<sup>8</sup>

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**Background:** Lifestyle is becoming more sedentary, physical activity is decreasing, and an increasing number of children are overweight. Obesity is associated with health risks. In addition to societal trends toward a sedentary lifestyle, children's motor coordination may contribute to whether they participate in physical activity. The consequences of poor coordination often involve exclusion from activities by peers and reduced motivation to participate.

**Aims:** A cross-cultural study, in the USA and in Israel, was conducted to examine the relationship between children's motor coordination and their physical activity, sedentary behavior, fitness and

obesity.

**Method:** Participants: Israel - 23 children with DCD and 18 typical children aged 6-11 years; USA - 30 children with DCD and 42 typical children aged 7-11 years. Children with DCD had scores <15th% on the Movement Assessment Battery for Children 2 (M-ABC-2). Instruments included: M-ABC-2, Strength subtest of the BOT-2, Physical Activity questionnaire, Accelerometer, 6 Minute Walk Test (6MWT).

**Results:** Significant differences were found between the DCD and Control groups on Fitness of the BOT-2, Israel ( $t=5.36$ ,  $p<.001$ ), USA ( $t=5.47$ ,  $p<.001$ ); 6MWT, Israel ( $t=3.74$ ,  $p<.001$ ), USA ( $t=3.17$ ,  $p<.01$ ). More time was spent in moderate + vigorous activity in Control group than in DCD group in both countries, but these differences were not significant. Risk for obesity (defined as a BMI z-score >85th %) was similar in the control groups of both countries, 20% in Israel and 23% in the USA, as well as in the DCD groups 47% in Israel and 45% in the USA. In both countries, there was a significantly higher percentage of children in the overweight category in the DCD compared to controls.

**Conclusion:** This study supports the relationship among coordination, activity level, fitness and risk for obesity within the populations of both countries.

### *Poster 62*

#### **Functional Strength Measurement (FSM) a valid and reliable instrument for children between 4-10 years of age**

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**Background:** To measure strength often isometric force measurement are used such as the Hand-Held Dynamometer (HHD) and the Oxford Medical Research Counsel (MRC). However, these instruments have a non-linear relation with functional strength. Between In 2007-2009 a new instrument to measure functional strength in children between 4-10 years has been developed: the Functional Strength Measurement (FSM).

**Aims:** 1) to develop reference values of the FSM for children between 4 and 10 years old; 2) to evaluate the concurrent validity and 3) to calculate test-retest reliability of the FSM.

**Method:** 488 typically developing children in the age 4-10 participated. All children were tested with the FSM, 153 children with the HHD and 69 children were tested twice on the FSM. Inter Class Correlation (ICC) was used to evaluate the test-retest reliability. Pearson correlations were calculated to compare the items of the FSM to items of the HHD. Factor analyse was performed to identify the factors behind this data. Standard scores were developed per year group.

**Results:** The children between 4-10 years of age can be tested reliably on the FSM (ICC of the items are between .79-.94). The correlations between the items of the FSM and the HHD ranged from were between  $r=.30$  to  $.73$  ( $p<0.05$ ). The factor analyses showed three factors which explained 77.8% of the variance. The analysis shows that isometric force and functional strength are two different factors. The third factor consisted of the functional strength items in the upper limbs measured with the FSM and isometric force in the upper limbs measured with the HHD.

**Conclusion:** This study showed that the FSM with its newly developed reference values is a valid and reliable instrument to register functional strength in young children. Moreover it confirmed that functional strength is not the same as localized strength of one muscle group, although they are related. One explanation for these findings can be that it is difficult to contract a single muscle group at this age. Another more likely explanation might be that in order to do a forceful daily activity you need more than just strength.

# Saturday 25 June, Poster Session D

## Assessment, School, and Handwriting

### Poster 63

#### The accuracy of the SchoolAMPS in children with DCD

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**Background:** One of the criteria to diagnose DCD is an assessment whether the problems of a child interfere with daily activities. Although questionnaires for parents and teacher are available, there is a need for objective assessment instruments for professionals. The SchoolAMPS is a standardized observational instrument that can be used by an occupational therapist for the assessment of a child during regular classroom activities. The child is scored on motor and process skills. The aim of this study was to examine the accuracy of the SchoolAMPS in detecting children with DCD.

**Methods:** Sixty children aged 6 to 11 years participated: 30 children with suspected DCD referred to a rehabilitation centre and 30 typical developing children. Parents and teachers filled out questionnaires: CBCL, TRF, DCD-Q and MOQ-T. Children were scored with both the SchoolAMPS and the M-ABC. All tests results were blinded. In this study the results are presented in two ways: the 15th as well as the 5th percentile M-ABC cut points served as reference standard for the presence of DCD.

**Results:** 15th percentile M-ABC cut-point served as reference standard. The sensitivity of the schoolAMPS motor scale is 76%, the specificity 90%, the Area Under the ROC curve (AUC value) is 0.90 (0.82-0.98). The sensitivity of the schoolAMPS process scale is 44%, the specificity 90% and the AUC is 0.85 (0.75-0.95). 5th percentile M-ABC cut-point served as reference standard: The sensitivity of the schoolAMPS motor scale is 87%, the specificity 80%, and the AUC is 0.88 (0.78-0.98). The sensitivity of the schoolAMPS process scale is 60%, the specificity 88% and the AUC is 0.83 (0.70-0.97).

**Conclusion:** The schoolAMPS can detect children with DCD. The specificity of the schoolAMPS scales is high; if a child scores at or below -2.0 SD on the schoolAMPS, it is likely that the child has DCD. The values of the sensitivity of the schoolAMPS scales are variable, which means that a score at or above -2.0 SD at the schoolAMPS does not exclude DCD.

### Poster 64

#### "Make My Day" - A new assessment for accounting a young child's typical day

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**Background:** All children develop as the result of their everyday experiences. It is important to document their routines and analyze them to see if they offer the sustained engagement that leads to learning opportunities. While assessing a child with DCD it's necessary to describe how the child's motor difficulties impact on his/her daily performance.

Young children (4-7) are often viewed as preverbal and unable to give a cogent description of their life experiences. Clinicians usually gather information on the child's performance on daily activities, from the child's parents. The collected information is not completely client centered, and does not reflect the DCD child's thoughts, perspectives, needs and priorities.

**Aims:** This presentation aims to describe the -"Make My Day" (MMD) as a "client centered" assessment tool which enables young children aged 4-7 and their parents to report on the child's daily routines and to identify difficulties and strength in their daily activities. The MMD assists the therapist and the family in goal setting. The MMD validity and reliability data will be presented.

**Method:** Expert's validity and concurrent validity (with the PEGS questionnaire and comparison between the child and parents reports) were conducted on the MMD. A convenience sample of 60 Israeli-Arab children age 4-7 and their parents were tested in 3 age groups.

**Results:** The MMD gives a broad and detailed picture of the child's daily log. Preliminary results show strong correlations between the 6-7 age group report and their parent's report of the child daily routines. The 4-5 and 5-6 age groups tended to appreciate themselves in higher scores than their parents. Children were utilizing the MMD in order to express their preferred goals and priorities enhancing participation.

**Conclusion:** Issues concerning the complexity of adopting a "client centered" approach in intervention with a young child will be discussed.

#### *Poster 65*

### **Analysis of Reliability of the Japanese version of the Motor Observation Questionnaire for Teachers (MOQ-T)**

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**Background and Purpose:** The Developmental Coordination Disorder (DCD) interferes with daily and academic performance, self-esteem and participation in play or physical activities at school. Teachers have many opportunities to observe a variety of motor skills at school. However, "clumsiness" in children has hardly attracted attention in Japan. Even though some screening tests are available in English, there is no suitable questionnaire to identify DCD by teachers in Japan. Recently, we have developed a Japanese version of the Motor Observation Questionnaire for Teachers (MOQ-T).

**Method:** We conducted the school-based nation-wide survey with a Japanese version of the MOQ-T, and the collected sample consisted of 8,272 children, aged 6 to 15 years.

**Results:** Cronbach's alpha for the full scale of a Japanese version of the MOQ-T was very high (0.95). Intraclass correlation coefficients (ICC) were used to examine the Internal consistency coefficients, and the ICCs were also very high, ranging from 0.947 to 0.955 for 18 of the items. Factor analysis with varimax rotation showed a 2-factor model, similar to the original MOQ-T.

**Conclusions:** In this nation-wide school-based study, the Japanese version of MOQ-T was administered to the additional older age-band, 12 to 15 years. The Japanese version of the MOQ-T is expected to be a useful screening instrument to identify and assess motor coordination difficulties of school children by teachers in Japan, and it enables the cross-cultural comparison of DCD as measured with the MOQ-T with data from other international questionnaires, such as a Japanese version of the DCDQ, which we developed recently.

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#### *Poster 66*

### **College students' praxis abilities as measured by the SIPT(R) Postural Praxis and Oral Praxis subtests**

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**Background:** numerous assessments and screening measures of praxis or motor coordination exist for pediatric populations, few can be used in adult populations. One such measure of praxis, the SIPT®, has been standardized through age 11.

**Aims:** (1) To determine if Postural Praxis and Oral Praxis subtests of the SIPT® can be used in young

adults without achieving a ceiling effect. (2) To determine if young adults who rated themselves as poorly coordinated, now or as children, perform more poorly on SIPT® subtests of praxis (imitation) compared to young adults who rate themselves as well-coordinated.

**Method:** convenience sample of participants aged 17-27 (n=72 at time of abstract submission with an intended n=100) was screened using the SIPT® Postural Praxis and Oral Praxis measures. In addition, participants completed a brief 4-item measure of their self-perceived motor coordination in comparison to peers as children and currently.

**Results:** data indicates a heavily negatively skewed distribution on the Oral Praxis test with 58% of participants scoring within one point of ceiling and 35% reaching ceiling. Scores on the Postural Praxis test show a moderate negative skew, with 36% within one point of ceiling and 8% reaching ceiling. No relationship was found between the self-perception measure and either SIPT® measure.

**Conclusion:** results indicate that the Postural Praxis and Oral Praxis measures could be useful in identifying praxis/imitation impairments in young adults, however, the addition of more difficult items might enhance discrimination. The lack of relationship between SIPT® measures and brief self-perception measure perhaps indicates that praxis/imitation represents a different construct than motor coordination. Future work should include actual assessment of motor skill using measures such as the BOT-2® and other self-report measures should be gathered in parallel to ascertain whether this measure correlates to self-perceived motor coordination or DCD diagnostic criteria.

#### *Poster 67*

#### **Client factors underlying disorganization among children diagnosed with Developmental DCD**

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**Background:** Disorganization is one of the more common reasons for referral of students with DCD to intervention in occupational therapy. Despite this fact, this deficit has not yet been studied in depth. Moreover, there is no enough information about the client factors that underlie disorganization among these students.

**Aims:** The purpose of this presentation is to describe the client factors that were found to be significantly associated with Disorganization and DCD.

**Method:** The study sample was comprised of 376 fifth and sixth grade Israeli school boys with normal intelligence. The children were classified to four study groups; DCD, DCD+Disorganization, Disorganization and Control. In the evaluation process the following procedures and instrument were administered, Questionnaire for Assessing Students' Organizational Abilities (QASOA) - T/P (teachers and parents versions), M-ABC, WISC-R-95, Conners' questionnaire, KAT, VMI, VMI-VP, Neurological Examinations (NE), COPM, TCA, DR and ROCF (Copy and Memory). The questionnaires were distributed to parents and teachers, all the other assessment tools were administered to each child individually.

**Results:** Significant correlations between Disorganization at school/QASOA-T and difficulties in visual perception/VMI-VP ( $r=-.40$   $p<.05$ ) and visual memory/ROCF- Memory ( $r=-.42$   $p<.05$ ) were found only within the DCD+Disorganization group. In addition, only within this group significant correlation was found between motor disabilities/M-ABC and soft neurological signs/NE ( $r=-.49$   $p<.01$ ).

**Conclusion:** The results from the current research indicate that unique client factors underlie disorganization among children with DCD. The implications from this result are: a. The procedure of evaluating children with DCD+ Disorganization should include an assessment to rule out the presence of visual perception disability, visual memory disability and soft neurological signs b. Identification of the client factors that are commonly associated with Disorganization and DCD will shed light on the main problem of the child and will help the therapist in planning an appropriate intervention program.



## Poster 68

### Undertreatment of motor problems in children with ADHD

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**Background:** Motor Problems are frequent in ADHD with severe impact on children's daily life. However, motor problems are usually not part of assessment for ADHD or part of regular intervention programs.

**Aims:** 1. Description of Motor Problems in a Dutch sample of children with ADHD  
2. Validation of the clinical impression of undertreatment of Motor Problems in ADHD by physical therapy.

**Method:** 235 Dutch children (5 -18 yrs) with ADHD participated.

ADHD and Motor Measures: Conners Parent+Teacher; SDQ; clinical interview (PACS); Developmental Coordination Disorder Questionnaire (DCD-Q), Groningen Motor Observation Scale, Movement ABC.

Statistics: Prevalence of motor problems rated by parents and teachers was investigated. Treated and untreated children were compared concerning age, gender, motor scores, ADHD scores, comorbidity with other conditions, and socioeconomic status of the parents by means of MANOVA and Chi square statistics. Logistic regression analyses were performed to predict which factors were related to treatment.

**Results:** 1. Parents and teachers reported motor problems in 34% of boys and 29% of girls with ADHD, both in children and adolescents. Movement ABC in a subgroup of children confirmed these results.

2. 46% of the children rated as motor impaired by their teacher and 59.8% of the children rated so by their parents had received physical therapy for their problems.

3. Untreated children frequently presented with comorbid Anxiety and Conduct Disorder. Boys were treated more often than girls (55% versus 40%). Treated and untreated children were similar in age, and rated similarly on ADHD inattentive and hyperactive-impulsive scales and parental socio-economic status.

**Conclusion:** Currently, half of the children with both ADHD and motor problems receive treatment for their motor problems. Behavioural factors play a role in referral and intervention. Given their frequent co-occurrence and impact on daily life, motor problems in ADHD should be assessed systematically and included in treatment planning. Motor problems do not get enough clinical attention. Especially girls are undertreated.

## Poster 69

### The relations between DCD, ADHD and IQ in community-based Japanese children and youth

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**Background:** Compared to attention deficit hyperactivity disorder (ADHD) and intellectual disability, less attention has been paid to developmental coordination disorder (DCD) in Japan. Previous studies (e.g., Fox & Lent, 1996) reported a high comorbidity of ADHD with DCD. We hypothesized a significantly positive correlation between the levels of DCD and ADHD symptoms. To our knowledge, no research has been conducted to examine the relation between motor coordination and intellectual ability in Japan.

**Aims:** The purpose of this study was to investigate that the relations between motor incoordination, ADHD symptoms and intelligence in community-based Japanese children and early adolescents.

**Method:** We administered the Japanese version of the Developmental Coordination Disorder Questionnaire (DCDQ; Nakai et al., 2010) and the Japanese translation of the ADHD-Rating Scale (Yamazaki, 2003) to a total of 7535 parents or care-givers of children who went to public day care centers, primary, or intermediate schools in a city in Aichi Prefecture, located in the central part of Japan. A total of 6,330 questionnaires (84%) were returned. Ninety-four percent of the respondents were mothers, five percent were fathers, and the rest were grandparents. Intelligence of primary and intermediate school children was measured by a group intelligence test (Okamoto et al., 1993).

**Results:** The total and subscale scores of the DCDQ were positively correlated with the ADHD-RS scores ( $p < .001$ ). On the other hand, the correlations between the DCDQ scores and IQ were significantly positive but low ( $.1 < r < .2$ ,  $n = 4887$ ,  $p < .01$ ).

### Poster 70

#### Graphomotor abilities in DCD and reading disability

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**Background:** The frequent co-morbidity observed between developmental coordination disorder (DCD) and reading disability (RD) or attention deficit hyperactivity disorder (ADHD) has led researchers to hypothesize a common aetiology or even, to the definition of a unique pathology, atypical brain development (Kaplan, 1992; Martin et al., 2010).

**Aims:** This project aims to investigate and, where appropriate, to describe the nature and intensity of graphomotor difficulties among children with DCD or RD. We hypothesize that children with RD, although not conforming to the diagnosis of DCD, present graphomotor performances which are qualitatively close of to those of children with DCD.

**Method:** Ten children with RD and ten children with DCD and ten typically developing children participated to the study. Children were between 8 and 12 years old. All children were evaluated using the Movement Assessment Battery for Children (Henderson and Sugden, 1992) and the French adaptation of the Beknopte Beoordelingsmethode voor Kinderhandschriften test (BHK, Charles, Soppelsa, & Albaret, 2004). Children were asked to perform graphomotor tasks on a digital tablet for the collection of kinematic and kinetic data. Tasks consisted in writing letters, learning to write an unfamiliar character, drawing simple and complex forms, drawing straight-line segments between two targets, a trail drawing item and drawing loops with and without visual feed back.

**Results:** Data analysis is currently in progress.

### Poster 71

#### Reading and writing performances in children with DCD

Hsiang-Chun Cheng<sup>1,2</sup>, Jenn-Yeu Chen<sup>3</sup>, Miao-Lin Shen<sup>4</sup>, Rong-Ju Cherng<sup>2,5</sup>

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**Background:** Developmental coordination disorder (DCD) refers to a delay in motor development which cannot be explained by any medical reasons. Studies in English speaking societies have found that children with DCD are at a higher risk of developing into learning disorder than typically developing (TD) children. However, the issue has not been investigated in a Chinese speaking society, Taiwan.

**Aims:** The present study examined the reading and writing performances in school-age (7-8 years) children with and without DCD.

**Method:** Twenty-nine children with DCD ( $7.9 \pm 0.6$  years) and 77 TD children ( $8.2 \pm 0.6$  years)

participated in the study. The Chinese Reading Achievement Test and the Basic Reading and Writing Test Battery were used to measure the reading and writing performances of the children. Learning disorder was suspected if children scored at or below the 25th percentile of the norms of these tests.

**Results:** No significant differences in the scores of The Chinese Reading Achievement Test were noted between children with DCD and TD children. However, children with DCD scored significantly lower on the writing subtests (copy of character and copy of short paragraph:  $13.0 \pm 5.2$  vs.  $15.3 \pm 5.3$ ;  $46.2 \pm 22.6$  vs.  $50.1 \pm 20.1$ ) than TD children. Seven (24%) children with DCD and 14 (18%) TD children were noted to have learning disorder based on the Chinese Reading Achievement Test. However, four (14%) children with DCD and 5 (6%) TD children were noted to have learning disorder based on the writing subtest of the Basic Reading and Writing Battery Test.

**Conclusion:** In disagreement with studies of English speaking participants, children with DCD in Taiwan did not have poorer reading ability than TD children. However, they showed poorer writing ability than TD children.

### *Poster 72*

#### **Dysgraphia and DCD, a complex relationship**

Serena Facecchia<sup>1</sup>, Paola Rampoldi<sup>1</sup>, Roberto Aversa<sup>1</sup>, Carlo Dibrina<sup>1</sup>

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**Background:** Learning disability: Dysgraphia and fine motor coordination

**Objective:** The aim of the study is to analyze fine motor coordination and visual perceptual skills, investigate their involvement into the process of writing and correlation to the Dysgraphia disorder.

**Method:** A group of 39 children was recruited, selected from a wide range of subjects referred to the Neuropsychology service of the Department of Pediatrics and Child Neuropsychiatry, "Sapienza" University of Rome. The children, aged 7,6-10,10, had a Specific Learning Disability (SLD) diagnosed according to the DSM-4 criteria, and poor quality of handwriting. The tests we administered were the following: WISC-III (Wechsler Intelligence Scale for Children, 1991); TPV (Developmental Test of Visual Perception, 1993), M-ABC (Movement Assessment Battery of Children;1992); BHK (The concise assessment method for children handwriting, 1987, Italian adaptation).

**Results:** At the WISC-III, the 39 children presented a normal range IQ-score. At the ABC Movement 22/39 children were diagnosed with DCD. According to the score obtained in the BHK scale, the sample was divided in two groups: 11 children poor writers (PW) and 28 dysgraphics (D). Three children poor writers were diagnosed with DCD at ABC Movement and 7 presented a difficulty in visual perception at TPV. In the dysgraphics group, 19 of them were children with DCD, while 23 children performed scores on visual perceptual and visual-motor skills at TPV below the normal regarding their age. From the whole sample of the study, 6 children (3 PW and 3 D) performed well scores on both ABC and TPV, and consequently, for those children we can't conclude a deficit neither in visual motor nor in visual-perceptual skills.

**Conclusions:** The results indicate the absence of a linear relationship between Dysgraphia and DCD and suggest to continue on studying the complex interaction between motor disability, fine motor coordination, visual perception deficit and attention abilities in wider case studies.

### *Poster 73*

#### **Factors underlying handwriting performance in children**

Hilde Van Waelvelde<sup>1</sup>, Barbara DeMey<sup>1</sup>, Griet Dewitte<sup>2</sup>, Stefanie Pieters<sup>3</sup>, Annemie Desoete<sup>3</sup>

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**Background:** Handwriting impairment is a frequently occurring disorder with high risk for academic underachievement. Tailor-made therapy requires knowledge of the underlying mechanisms of handwriting impairment.

**Aims:** To unravel the association between handwriting and visual motor integration, motor coordination, general motor ability and reading speed.

**Method:** Participants were 209 children, between 7 y 0m and 10y 2m (mean age = 8y 6m). Twenty-seven children were recruited in regular schools and 182 children were from schools for special education or were receiving multidisciplinary therapy in an ambulant rehabilitation centre. All children had an IQ above 85.

All children were assessed with several tests in a random sequence. The SOS test was used to evaluate handwriting ability. Six criteria are used to evaluate the quality of handwriting. Writing speed is measured by counting the amount of letters. The Beery VMI test was used to evaluate visual motor integration. The child has to copy geometric figures. The supplemental VMI Motor Coordination test (VMI-MC) requires drawing the same figures within the borders of a trail. The M-ABC-2 was used to evaluate general motor ability. The One Minute Reading Test evaluated writing speed. Regression analysis was adopted to explore the association between writing quality and writing speed and the different tests.

**Results:** The model to explain quality of writing showed  $R = 0.49$  with VMI-MC and M-ABC-2 as significant explaining factors with respectively  $\beta = -0.22$ ,  $p = 0.010$  and  $\beta = -0.17$ ,  $p = 0.015$ .

The model to explain writing speed showed  $R = 0.68$  with as only significant explaining factor the One Minute Reading test,  $\beta = -.611$ ,  $p < 0.001$ .

**Conclusions:** Handwriting is a complex motor skill explained only partly by motor coordination, general motor ability and reading speed. Visual motor integration seems not to be an important explaining factor.

#### *Poster 74*

### **A conceptual model of handwriting acquisition to guide handwriting evaluation and instruction**

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**Background:** Handwriting is developmental and improves with instruction. Handwriting variability is typical when children are learning but it decreases as handwriting proficiency increases. This is expected, even though demands on handwriting performance quickly become more complex once children receive formal instruction.

**Aims:** What is lacking is a sensitive instrument to monitor the handwriting development of children, from age 5-7 to 7-7 years, during this acquisition phase. The Model of Handwriting Acquisition (MHA) has been devised as a conceptual frame to guide construction of such an instrument.

**Methods:** A comprehensive literature review of the existing theoretical models of handwriting and handwriting evaluation was conducted to inform the MHA structure and content.

**Results:** The literature review highlighted the inter-relatedness of neuropsychology and occupational therapy approaches to handwriting evaluation. The MHA is a synthesis of the model of multiple constraints on handwriting first proposed by Berninger et al. and Taxonomic Code of Occupational Performance proposed by Townsend & Polatjako. The multiple constraints on handwriting (neurodevelopment, language and cognition) are juxtaposed with a hierarchy of occupational complexity (copying, dictation and composition).

**Conclusions:** Handwriting is a complex motor skill that children with DCD often find difficult, but comorbidity related to language and cognitive facility is common with DCD. Handwriting is also language by hand and requires directed attention to sequence letters and words. To minimize the detrimental effects of DCD on handwriting development, the MHA provides an organizing frame to evaluate the interaction between task complexity and concurrent comorbid constraints on handwriting performance during the acquisition phase. It is anticipated that effective evaluation can contribute to more effective intervention. This is important because handwriting remains the principle means by which children demonstrate, and are assessed on, what they know.

## Poster 75

### Inter-observer reliability of the Concise Assessment Method for Children's Handwriting (BHK): findings from a research

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**Background:** Poor handwriting quality is a warning signal for Specific Learning Disabilities and fine motor dysfunctions like Developmental Coordination Disorder (DCD).

The Concise Assessment Method for Children's Handwriting (BHK Scale) (Hamstra-Bletz et al., 1987) is a widely used tool in the assessment of handwriting quality of first grade children.

**Aims:** Children's poor handwriting evaluation has to be done through a reliable tool, able to reduce observers' subjectivity. So, the aim of our study is to test the inter-observer reliability of the BHK Scale. We proceeded to obtain consensus over each of the 13 items of BHK Scale.

**Methods:** A sample of 20 children with poor handwriting was selected and assessed using the BHK Scale as proposed in the Italian version (Di Brina, 2011). A set of 6 discussion and learning sessions was conducted in order to get an agreement on the interpretation of each item of the Scale among the observers. The analysis of the children's writing was conducted independently by 6 professional observers without experience working with the BHK Scale. The test-retest reliability was checked with a 6 week interval.

**Results and conclusions:** In the retest session results obtained were more homogeneous than those of the test. The description and correlation ranges of the BHK items obtained from the investigation will be discussed.

## Poster 76

### Pre-writing abilities in children with DCD

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**Background:** Children with developmental coordination disorder (DCD) are reported to be at risk of developing writing difficulties. However children with difficulties in writing usually will not be identified until they enter the elementary school and face the writing need. Pre-writing skills such as line and figure tracing and the ability of eye-hand coordination are related to handwriting. However, the task of line and figure tracing performance is traditionally on paper and the assessment is qualitative.

**Aims:** To quantitatively compare the pre-writing (eye-hand coordination) performance in children with DCD and typically developing (TD) children on a self-developed computerized test 'Literacy Start'.

**Method:** Nine children with DCD (all boys, age:  $6.7 \pm 1.2$  years) and 18 age- and gender- matched TD children participated in this preliminary study. They were tested with 'Literacy Start', the Chinese version of 'the Beery-Buktenica Developmental test of Visual-Motor integration' (VMI) and two VMI-supplementary tests. The 'Literacy Start' is a path-tracing task which includes 20 figures of various difficulty levels. The test recorded performance parameters such as error number, trajectory length outside the path, numbers of outside the line barrier of the path and movement time. The test was given to 123 preschool and school children. Independent t tests were used to compare the group differences. Discriminate analysis was used to identify the influence of the difficulty factors. Correlation test was used to examine the correlation of the VMI test, VMI-supplementary tests and the 'Literacy Start'.

**Results:** The results showed that children with DCD presented more errors, longer trajectory length outside the path and greater number of time when their pen crossed the line barrier of the path. The discrimination rate of children with DCD and TD is 92.9%. **Conclusions:** Children with DCD have poorer pre-writing skills (line tracing and eye-hand coordination) than TD children. Our computerized pre-writing skills test 'Literacy Start' can provide quantitative data of pre-writing ability.

## Poster 77

### **Rotoscopy pre-writing interface: using computer animation technique to assist the teaching of handwriting for children with DCD**

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**Background:** Rotoscopy is a traditional animation technique that has been extensively adopted in computer animation, tracking and video. Only a few studies explore this technique as an intervention to assist people with learning difficulties. Our hypothesis is that children who experience movement disorders may benefit from the opportunity to develop and practice skills using rotoscopy, as the technique affords qualities that are conducive to imitation and expressive movement. In drawing attention to action rather than cognition this process may reduce the demand on fine motor skills which is known to be de-motivating for a child with Developmental Coordination Disorder (DCD).

**Aim:** Our overarching goal is to investigate the potential of manual rotoscopy to assist handwriting skills for children with DCD. With support from our prototype systems, the proposed methods aim to place these developments in an original context.

**Method:** A significant aspect of the methodology will be to develop a rotoscopy interface using an iterative process of experience prototyping. A user-centred methodology is being used to identify requirements of children with DCD and a pedagogical context for the rotoscopy prototypes.

**Results:** Currently we are developing a series of rotoscopy-handwriting prototypes, which will be followed by undertaking contextual analysis and users' reflection. The testing process will take place at the Dyscovery Centre, University of Wales Newport.

**Conclusion:** Rotoscopy may prove appropriate for children with DCD as it supports imitation and expressive movement. Importantly, the close harmony of input and output device play an important role as a medium of communication between children and the methods, as the perceptual and behavioural mapping input is rendered visible through the output on a large surface such as an interactive whiteboard. Our next milestones will be to undertake contextual analysis of the prototype systems as well as user's feedback and reflection.

## Poster 78

### **The effects of handwriting task program in poor writers with and without DCD**

Silvia Baldi<sup>1</sup>, Michela Nunzi<sup>1</sup>, Davide Tufarelli<sup>1</sup>

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**Background:** Research has demonstrated that children with poor handwriting improve their performance after a specific program and has been shown that poor handwriting is a persistent trait when untreated. The handwriting intervention approaches documented in the literature include biomechanical, sensorimotor, teaching-learning strategies, cognitive problem solving strategies and self-instruction techniques.

**Aims:** The purpose of this study was to evaluate the effects of a Handwriting Task Program (HTP) on handwriting performance in poor writers with and without Developmental Coordination Disorder. The HTP is a task oriented training program based on cognitive-behavioural intervention.

**Method:** Twelve children who are poor writers, aged from 8 to 10 years, participated in the study: 6 children with DCD and 6 children without DCD. To verify the effectiveness of HTP, a single case ABA design was applied using a quantitative analysis of handwriting through specific features of errors. To assess the statistical significance of the results, a Test C was used.

**Results:** Handwriting performance in all participants improved, secondary to the intervention, but for children with Developmental Coordination Disorder change is less significant.

**Conclusions:** Children with poor handwriting can benefit from a Handwriting Task Program to improve handwriting legibility. The effects of training however, may depend on the specific developmental profile of the subject.

**"Let's Go!" efficacy of a school-based health program for students aged 11-14 with DCD and coordination difficulties**

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**Background:** School psychologists have found that many students who are diagnosed with Developmental Coordination Disorder (DCD) or who have undiagnosed coordination problems struggle with school performance, self-concept, and participation in physical activity. In 2009-2010 "Let's Go" (a pilot project) was instigated at a high-needs junior high school as a way to provide specific intervention to students (11-14yrs) who have motor difficulties. There were positive results for those students who attended this program, including improved physical, emotional, and academic outcomes.

**Aims:** The current research expanded upon that pilot project to provide an empirical measure of program effectiveness. As school psychologists, our desire is not only to raise awareness of DCD and other motor learning problems, but also to identify the most effective service delivery models needed in schools. This project provides evidence-based data for implementing specific programs for students with DCD and other motor learning problems.

**Method:** After students with motor learning disabilities were identified by a school psychologist, students were invited to participate in pre-assessment of fundamental motor abilities, general health, and self-concept. Data about school attendance, social interactions, and academic achievement was also collected. Program participants attended weekly sessions focusing on the development of basic motor skills and attended workshops on healthy choices. Ten students served as a control group. After five months, a post-assessment of the same measures was conducted.

**Results:** It is anticipated that results of the current study (completed May 2011) will be consistent with the pilot program. It is believed that the students who participate in the "Let's Go" program will demonstrate improvements in a number of areas over the control sample.

**Conclusion:** More attention to intervention must be directed to students with motor difficulties as proper programming may improve the performance of specific motor skills, academic output, and psycho-social well-being.

# Saturday 25 June, Poster Session E

## Parents, Quality of life, and Intervention

### Poster 80

#### A preliminary examination of the effects on siblings of DCD in the family, and the implications for professionals

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**Background:** Researchers have considered the family dynamics and relationships when one member has a disability in a number of developmental disorders including Attention Deficit Hyperactivity Disorder (ADHD), Autism Spectrum Disorders (ASD) and physical disabilities. However, little is known of the effects of DCD on the siblings of children with DCD.

**Aims:** To establish the nature of siblings' feelings in respect of their sibling with DCD.

**Method:** A non-standardised, web-based questionnaire was completed by 35 voluntary participants (mothers) with a child with DCD (between 5 - 16 years) and at least one child without DCD. Participants were asked to select answers from closed questions on a 4-point Likert scale.

**Results:** 82.9% of participants (mothers) and 68.6% of their partners (fathers) reported that they treated their DCD child differently from their non-DCD children. 51.7% of the non-DCD siblings were believed to have noticed being treated differently. 52.9% of grandparents were believed to treat their DCD grandchild differently from their non-DCD grandchildren. 72% of the non-DCD siblings were reported to be aware that their sibling had been diagnosed with DCD. 97.1% of non-DCD siblings were not included or consulted as part of the assessment of their DCD sibling.

**Discussion:** This preliminary research shows that siblings are unlikely to be unaffected by their brother or sister's diagnosis of DCD given that a majority are aware of the diagnosis and have noticed differences in the way they and their DCD brother/sister are treated by their parents and grandparents, and others. This research is the first stage in a more detailed study to follow, to understand the sibling's voice in the family.

### Poster 81

#### Parents' perception toward motor proficiency of children with DCD: a preliminary study

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**Background:** Several qualitative studies have investigated parents' perception on movement difficulties of children with DCD. Nonetheless, limited studies adopted the quantitative method to examine this issue.

**Aims:** This study attempted to compare the difference of perception toward motor performance of children with DCD between their mothers and fathers. **Method:** Children diagnosed as "unspecified developmental delay" were recruited from a cohort of 124 pupils attending physiotherapy intervention in hospital. After excluding those with mental and medical problems and neuromuscular diseases, 17 children with parental permissions participated in the present study, and were assessed by the Movement Assessment Battery for Children-2 (MABC-2) test. Furthermore, parents were requested to complete the MABC-2 checklist in order to understand their perceptions toward children's motor performance in daily and academic activities.

**Results:** According to the MABC-2 test, 9 out of 17 children were identified as DCD. The anthropometric variables failed to reveal any significant difference between the DCD and non-DCD



groups, while the DCD group significantly performed poorer in the Manual Dexterity ( $p<.01$ ), Balance ( $p<.01$ ) and Total Test Score ( $p<.001$ ). As for the parents' perceptions of the DCD group, even though their fathers usually worked longer time and had less time accompanying them, no significant difference in the scores of the MABC-2 checklist between fathers and mothers was found. All of parents categorised their children into the "Red Zone", indicated "highly likely to have a movement difficulty". **Conclusion:** Fathers and mothers of children with DCD may have similar perception toward motor performance of their children although fathers scored lower in the MABC-2 checklist, indicating that they probably overestimate children's motor abilities.

### *Poster 82*

#### **Motor or behavioral problem? Dilemmas recognizing and parenting a child with DCD in Brazil**

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**Background:** Although there is evidence that motor coordination problems affect about 6% of school-age children, in Brazil these problems receive little attention and the impact of Developmental Coordination Disorder (DCD) is underestimated when compared to other developmental disorders. The literature indicates that parents are the first to notice the problem, yet few studies describe their perceptions and beliefs concerning the impact of DCD in the child's and family life.

**Aims:** To investigate the perception of Brazilian parents about the functional performance of children identified with DCD and the impact of the disorder in the family routines.

**Method:** Qualitative phenomenological study in which the mothers and grandmothers of four boys and one girl, eight years old with DCD, were interviewed with open ended questions. The interviews were recorded and transcribed for thematic analysis.

**Results:** Three themes emerged from the interviews: to do and not to do, the relationship with friends, the dilemmas of caretaking. The results indicate that the respondents perceive some of the children's difficulties in self-care, play and in the relationships with peers. However, behavioral issues caused more concern and motivate families to seek help or structure adaptive strategies. There were also some differences in the reports associated with educational levels: parents with higher education levels expressed concerns regarding their child's feelings as they struggle with daily tasks. The analysis shows that Brazilian parents have difficulties identifying motor coordination problems, referring more to behavioral and / or emotional issues. It seems that in their understanding behavioral issues are more relevant and dissociated from motor problems.

**Conclusion:** There is a need for more information regarding DCD, its identification and short and long term impact in the children's lives. Educational level seems to influence parents' perceptions and they all should be better informed about treatment options and support within the public health system.

### *Poster 83*

#### **Quality of life for families of children with DCD: cohesion and conflict**

Amanda Kirby<sup>1</sup>, Lisa Edwards<sup>1</sup>, Ann Rees<sup>1</sup>, Marie Thomas<sup>1</sup>

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**Background:** Until now no study has considered levels of conflict or cohesion in Developmental Coordination Disorder (DCD). Conflict can occur in families as a result of difficulties in maintaining relationship closeness. Cohesion has been described as the emotional bonding between family members. Confounding factors such as Attention Deficit Hyperactivity Disorder (ADHD), gender and age may have an effect on these relationships in children with DCD.

**Aims:** This study investigated levels of cohesion and conflict in families with children with DCD compared to families with typically developing children, and the influence comorbidity may have on

outcomes.

**Method:** Ninety-nine families with children diagnosed with DCD and sixteen control families completed the cohesion and conflict items on the Family Environment Scale. Screening questionnaires for ADHD, Autism Spectrum Disorder and Dyslexia were also administered. Comorbidity, gender and age banding were used as grouping variables to explore any differences in cohesion and conflict scores.

**Results:** Within the DCD group there was significant effect of age range on cohesion scores but not on conflict scores, with more cohesion within the control families. Gender did not influence levels of cohesion or conflict. The control group showed no group differences for either age range or gender. There were differences between the DCD subgroups and controls and between different DCD subgroups. There were no differences in conflict and cohesion scores between the DCD and ADHD group and the DCD group.

**Conclusions:** Cohesion in families changes typically in teen years. In the DCD group this change has been shown to occur earlier. These findings will be further discussed.

#### *Poster 84*

##### **Exploring quality of life of children with DCD: a pilot study**

Jill Zwicker<sup>1</sup>, Cheryl Missiuna<sup>2</sup>, Susan Harris<sup>1</sup>, Anne Klassen<sup>2</sup>

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**Background:** Research from interviews of parents of children with developmental coordination disorder (DCD) suggests that DCD may be detrimental to their children's quality of life (QOL), but no studies have examined QOL from the perspectives of children themselves.

**Aims:** The purpose of this qualitative study was to understand QOL of children with DCD by exploring the following research questions: (1) what is it like having DCD? and (2) how does DCD affect the QOL of children with this disorder?

**Methods:** An interpretive description approach was used. Children were invited to participate if they: were aged between 8 and 12; were identified by occupational or physical therapists as having probable DCD based on clinician judgment and motor impairment  $\leq$  15th percentile on the Movement Assessment Battery for Children-2; scored in the 'indicative' or 'suspected' range on the parent-completed DCD Questionnaire; and did not have any commonly co-occurring conditions. Eligible children were provided with a disposable camera and asked to take photos of activities they enjoy doing and activities they wish they could do. These photographs were used to stimulate discussion during in-depth interviews. Interviews were audio-recorded and transcribed verbatim. We used line-by-line coding to establish categories and themes and constant comparison to examine relationships within and across codes and categories. Multidisciplinary perspectives of the investigators incorporated into the interpretation.

**Results:** Interviews were conducted with 13 participants. Preliminary themes include: *Feelings of Inadequacy and Isolation*, *No Big Deal: I've Grown Up With It*, and *Recognizing Personal Strengths*.

**Conclusions:** Study findings may increase understanding of the impact of this disorder on the lives of children, hopefully leading to greater support and service for children with this disorder. This study provides the first step in a line of inquiry to develop a conceptual model of QOL and a condition-specific measure for children with DCD.

#### *Poster 85*

##### **The relations between sense of coherence, hope and effort, and participation among young children with DCD**

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**Background:** Participation is a person's involvement in daily activities in a variety of environments, roles and life situations. Children with Developmental Coordination Disorder (DCD) experience

difficulties in gaining academic achievements or in their engagement in activities of daily living. Motor difficulties have a negative effect on the ability to participate, as well as on various affective components. Senses of coherence, effort and hope have not yet been assessed, within the context of participation, in children with DCD.

**Aim:** The purpose of the present study is to assess the relations between participation and senses of coherence, effort and hope among children with and without DCD.

**Method:** Fifty subjects aged 5-6 years participated in the study. Twenty five were children diagnosed with DCD, and the other 25 were typical children. The DCD diagnosis was established according to the DSM-IV criteria and the M-ABC-2 test. All children completed the coherence questionnaire for children as well as the children's questionnaire on effort and hope. Parents completed the Children Participation Questionnaire (CPQ), and the Performance Skills Questionnaire (PSQ).

**Results:** Children with DCD had lower performance skills, lower sense of coherence, and achieved lower scores on hope and effort questionnaires than their peers. They enjoyed their participation less and their parents were less satisfied in comparison to the control group. Significant correlations were found between sense of coherence, effort and hope to participation. Process skills were found to be the main predictor for explaining child's participation.

**Conclusion:** While we treat children with DCD we have to consider socio-psychological aspects that may be weakened as well.

#### *Poster 86*

#### **Motor problems and low preference for active play in childhood are associated with low self-rated performance in physical education in adolescence**

Jarno Purtsi<sup>1</sup>, Marko Kantomaa<sup>2</sup>, Anja Taanila<sup>3</sup>, Jouko Remes<sup>4</sup>, Helena Viholainen<sup>5</sup>, Pauli Rintala<sup>6</sup>, Timo Ahonen<sup>7</sup>, Tuija Tammelin<sup>2</sup>

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**Background/Aim:** The aim of this prospective longitudinal study was to investigate whether motor problems and low preference for active play in childhood are associated with self-rated performance in physical education (PE) in adolescence.

**Method:** The study sample consisted of the Northern Finland Birth Cohort 1986 (NFBC 1986) composed of 4656 children whose parents responded to a postal inquiry concerning their children's active play and motor problems at age 8 years and who self-rated their performance in PE at age 16 years compared to their coevals. Results were obtained from multinomial logistic regression and adjusted for socio-economic position, body mass index and physical activity level at 16 years.

**Results:** At adolescence the prevalence of low self-rated performance in PE was 6.5% among boys and 6.9% among girls. At 8 years parents reported more gross motor problems among boys (5.9%) than girls (2.8%). Fine motor problems were also more prevalent among boys (14.4%) compared to girls (1.7%). At 8 years 15.6% of boys and 14.3% of girls had low preference for active play.

Low preference for active play in childhood was associated with low performance in PE (boys: OR 5.81, 95% CI 3.73'9.05; girls: OR 3.89, 95% CI 2.61'5.79) in adolescence. Gross (OR 4.38, 95% CI 2.34'8.18) and fine (OR 1.65, 95% CI 1.03'2.67) motor problems were associated with low performance in PE among boys. Gross motor problems were associated with low performance in PE also among girls (OR 4.46, 95% CI 1.84'10.80).

**Conclusion:** Low preference for active play and motor problems in childhood were associated with low self-rated performance in PE in adolescence. Targeted interventions supporting children's motor learning and participation in active play may thereby promote physical activity and performance in PE in adolescence.

*Poster 87*

**Developmental Coordination Disorder and obesity in Taiwanese boys and girls**

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<sup>1</sup>National Taiwan College of Physical Education, Taichung, Taiwan, <sup>2</sup>China Medical University

**Background:** Limited studies had examined the relationships between developmental coordination disorder (DCD) and obesity using body mass index (BMI) to classify overweight and obese children. However, BMI does not directly reflect both fat and fat-free components of body weight.

**Aims:** The purpose of this study was to investigate the associations between DCD and obesity and to examine the difference between genders.

**Method:** 2730 children (1468 boys, 1262 girls) aged nine to twelve years were recruited randomly in 19 elementary schools around Taiwan. We used bioelectrical impedance analysis to measure percentage of body fat (PBF) to identify overweight and obese children, and used the Movement Assessment Battery for Children test (MABC test) with the Taiwan norm to diagnose DCD. According to cut off points in PBF from past studies, boys and girls were divided into the obese, overweight and normal-weight, respectively. A Pearson Chi-Square analysis was used to compare the prevalence of obese children within DCD, borderline DCD (bDCD) and typically developed (TD) group.

**Results:** The results revealed that DCD children were more likely to be obese and overweight (27% and 25%, respectively) compared to TD children (21% for both) ( $\chi^2 = 13.10$ ,  $p < .05$ ). In boys, there were more obese children in DCD and bDCD groups (34% for both) than those in TD group (26%) ( $\chi^2 = 9.65$ ,  $p < .05$ ). In girls, the prevalence of obesity and overweight was much higher in DCD children (21% and 38%, respectively) than those in TD children (16% and 23%, respectively) ( $\chi^2 = 18.76$ ,  $p < .01$ ).

**Conclusion:** According to the results from large numbers of participants, this study concluded that children with DCD in Taiwan may have higher risk in overweight or obesity.

*Poster 88*

**Analysis of scientific evidence regarding neuromaturational interventions for children DCD**

Emmanuelle Jasmin

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**Background:** In regard of the scientific literature, neuromaturational interventions, such as sensory integration, seem to be controversially for children with developmental coordination disorder (DCD). Instead, cognitive and specific interventions tend to be more supported by scientific evidence and thus, recommended for children with DCD. However, many professionals working in paediatrics use sensory integration principles in their practice.

**Aims:** This conference propose a summary based on a literature review that examines the degree of scientific evidence of neuromaturational interventions for children with DCD.

**Method:** Selected studies had to be published between 1999 and 2009. In addition, children needed to be diagnosed with DCD, dyspraxia or a problem of coordination nonrelated to cerebral palsy and one group or one child should have received a neuromaturational intervention. Evidence-based criteria were used to select the articles. Studies were analyzed according the degree of evidence, the type of interventions, samples, measures and results.

**Results:** This conference will suggest that some neuromaturational interventions, based on sensory integration and perceptive-motor intervention, are more effective to improve the motor skills of children with DCD.

**Conclusion:** Further studies will be proposed to evaluate the impact of these interventions on functional skills and academic learning.

## Poster 89

### A sensorimotor approach to the training of manual actions in children with DCD

Winona Snapp-Childs<sup>1</sup>, Elizabeth Casserly<sup>1</sup>, Geoffrey Bingham<sup>1</sup>

<sup>1</sup>Indiana University, Bloomington, United States

**Background:** Previous research has implicated problems in the sensori-motor control of limb movements in the etiology of DCD (e.g. Grove & Lazarus, 2007; Inder & Sullivan, 2005; Mon-Williams, et al., 1999; Smyth & Mason, 1998; Volman & Geuze, 1998). New technology makes it possible to employ active, robot-assisted, training regimens to improve sensori-motor control of the limbs (Casserly, et al., 2010).

**Aims:** We investigated whether practice of the sensori-motor control of limb compliance yields improved manual control in children with DCD.

**Methods:** The task was to push a fish along a visible wire 'racing track' path on a computer screen while racing a competitor fish. The child grasped a stylus attached to a force feedback haptic virtual reality device (Phantom Omni); the stylus controlled a virtual stylus in the display used to push the fish. To move the fish, the child had to keep the virtual stylus on the wire path. The task was made easier by magnetically attracting the stylus to the wire path. Task difficulty was altered by controlling magnetic strength, path length and competitor speed.

Six children with DCD (7-years, 11 months to 8-years, 11 months old) and 4 age-matched TD peers participated in a baseline testing session where they raced a medium-paced fish on the shortest path two times with eight magnetic strengths. The children with DCD also participated in five, once-a-week, 20 min sessions and a post-training session. During training, all children started with the greatest magnetic strength, shortest path, and slowest competitor and progressed through increasing levels of difficulty by 'beating the competitor.'

**Results:** At baseline, children with DCD were significantly impaired relative to age-matched TD peers. With training however, children with DCD improved to exceed the performance of their age-matched TD peers.

**Conclusion:** Children with DCD are well able to learn to control compliance in manual actions. Their successes have strong clinical implications for the training of everyday manual activities such as drawing and handwriting.

## Poster 90

### Coordination disorders in the early years

Mary Chambers<sup>1</sup>, David Sugden<sup>1</sup>

<sup>1</sup>University of Leeds, Leeds, United Kingdom

**Background:** The years from three to six are a time when children develop fundamental movement skills that are the building blocks for the functional movements they use throughout their lives. However, some children on entry into school do not have a full range of these fundamental skills and this lack of competence in motor skills often affects their normal activities of daily living and possibly their academic work.

**Aims:** One of the aims of the project was to examine the efficacy of 'low level' intervention programmes for children identified with coordination difficulties.

**Method:** A total of 36 children with coordination difficulties aged three to five years were identified and individual profiles mapped out. The first intervention phase involved one group of children working on activities with teachers for 10 weeks. Each child had three to four sessions a week lasting for approximately 20 minutes. For the second phase of intervention, a second group of children worked with teachers in the same way as Group One.

**Results:** At the beginning of the study, all 36 of the children scored below the 15th percentile. By the end of the project only three of the children remained below the 5th percentile and four remained between the 5th and 15th percentile.

**Conclusion:** 'Low level' intervention programmes for children identified with problems have been found

to be effective and the majority of children who received 'low level' intervention programmes have shown significant improvement in their motor skills. Using the example of three cases, this presentation will explore the preparation of individual sets of activities from initial assessment to the development of appropriate activities

### *Poster 91*

#### **Vision therapy improve DCD status**

Dané Coetzee<sup>1</sup>, Anita Pienaar<sup>1</sup>

<sup>1</sup>North-West University, Potchefstroom Campus, RSA, Potchefstroom, Republic of South Africa

**Background:** Children with Developmental Coordination Disorder (DCD) are a heterogeneous group regarding underlying problems. Poor ocular muscle control show relationships with motor coordination problems, which can contribute to academic problems, poor motor skill development and fundamental movement skills needed for successful sport participation. Vision therapy is indicated to be a possible way to address poor ocular motor control.

**Aim** of the study: To determine whether vision therapy will have a positive influence on the DCD status of children diagnosed with DCD.

**Method:** Children (N = 32) with a mean age of 95.66 months form part of the study. The Movement Assessment Battery for Children (MABC) was used to classify children into DCD categories (< 15th percentile) while the Sensory Input Systems Screening Test and Quick Neurological Screening Test II (QNST) were used to evaluate ocular motor control. A pre-test-post-test cross-over design was followed with a retention test two years after completion of the intervention to determine the lasting effect of the intervention. The 18-week vision therapy program was executed once a week for 30 ? 45 minutes during school hours, after which the experimental and the control groups were swapped around.

**Results:** Vision therapy had a positive effect on the DCD status of all the children. Both the experimental - and control group improved significantly after intervention in the MABC total ( $p < 0.05$ ); manual dexterity skills ( $p < 0.05$ ); ball skills ( $p < 0.05$ ) and static and dynamic balance skills ( $p < 0.05$ ), and this effect was still evident two years later during the retentiontest ( $p < 0.05$ ).

**Conclusion:** Vision therapy is recommended for children with DCD who experience motor problems as a result of poor ocular motor control. Vision therapy should be given as early as possible to prevent the negative influences it has on academic performance, motor skill development and fundamental movement skills.

### *Poster 92*

#### **An investigation of the impact of regular use of Wii Fit to improve motor and psychosocial outcomes in children with DCD**

Elisabeth Hill<sup>1</sup>, Victoria Jones<sup>2</sup>, James Hammond<sup>2</sup>, Ian Male<sup>3</sup>, Dido Green<sup>4</sup>

<sup>1</sup>Goldsmiths, University of London, London, United Kingdom, <sup>2</sup>Brighton and Sussex Medical School, <sup>3</sup>Sussex Community Trust, <sup>4</sup>Tel Aviv University

**Background:** Children with DCD experience poor motor and psychosocial outcomes. Interventions are often limited within the health care system, and little is known about how technology might be used within schools or homes to provide appropriate motor experiences that would promote the motor skills and/or psychosocial development (e.g., self-esteem) of these children.

**Aims:** To evaluate whether short, regular school-based sessions of movement experience using a commercially available home video game console (Nintendo's Wii Fit) would lead to benefits in both motor and psychosocial domains in children with DCD.

**Method:** A randomised controlled trial of children with DCD, or at high risk of the disorder, was conducted. Children were randomly assigned to an intervention (n=10) or comparison (n=9) group. The intervention group spent 10 minutes thrice weekly for one month using Wii Fit during the lunch break,

while the comparison group took part in their regular Jump Ahead programme. Pre- and post-intervention assessments considered motor proficiency, self-perceived ability and satisfaction and parental assessment of emotional and behavioural problems.

**Results:** Positive changes in psychosocial well-being were reported for the intervention group, but not the comparison group. Motor proficiency (via the Bruininks-Oseretsky Test of Motor Proficiency) improved in all members of the intervention group following the one-month intervention period.

**Conclusion:** This simple, popular intervention represents a plausible way families could support their child's motor and psychosocial development. It is a non-invasive activity that allows the child to develop not only motor skills and potentially improve psychosocial outcome, but might also support social engagement in a way that is arguably lacking in those who experience less peer engagement in physical activities. We are currently extending this work to provide cross-over data to allow clearer conclusions on the influence of Wii Fit over Jump Ahead in this population, and also those with learning disabilities. These results will be reported at the conference.

### *Poster 93*

#### **Motor performance abilities of children aged 12-16 years participating in a multidisciplinary program for overweight and obese adolescents: preliminary results**

Emily Ward<sup>1</sup>, Leon Straker<sup>2</sup>, Kim Laird<sup>3</sup>, Deborah Kerr<sup>2</sup>, Alexandra McManus<sup>4</sup>, Melissa Davis<sup>2</sup>, Angela Fielding<sup>2</sup>, Marg Brewer<sup>2</sup>, Tony Wright<sup>2</sup>, Anne Smith<sup>2</sup>, Nicola Hamilton<sup>3</sup>, Kylie Johnston<sup>5</sup>, Rebecca Abbott<sup>6</sup>

<sup>1</sup>Curtin University, South Perth, Australia, <sup>2</sup>Curtin University, Perth, Australia, <sup>3</sup>Princess Margaret Hospital for Children, Perth, Australia, <sup>4</sup>Curtin Health Innovation Research Institute, Perth, Australia, <sup>5</sup>University of South Australia, Adelaide, Australia, <sup>6</sup>University of Queensland, Brisbane, Australia

**Background:** Current research indicates that children who are overweight or obese are more likely to demonstrate poorer motor performance and obesity is recognized as a co-morbidity of Developmental Coordination Disorder (DCD). Curtin University runs a multidisciplinary program for children aged 12-16 years who are overweight or obese. The program involves four hours a week of contact time for both the child and parent/carer with a dietician, psychologist, physiotherapist and social worker in a group setting aiming to educate families and provide an opportunity to exercise in a clinic gymnasium (2 x 1 hour session) over an eight week period.

**Aims:** The aims of the exercise sessions are to increase confidence with physical activity, improve cardiovascular fitness and increase strength.

**Method:** Participants have been recruited through local Medical Practitioners, School Nurses and Community Newspapers. The Movement Assessment Battery for Children, Second Edition (MABC-2) was used as part of a battery of tests pre and post intervention and will be administered again at 3 and 6 months post intervention.

**Results:** Currently there is data for 8 participants (average BMI = 29.05 SD 3.15) and this number will grow with programs funded to continue for the next three years. The analysed data for the 4 male and 4 female (average age -13years 8 months SD 13 months) participants indicated age appropriate motor performance pre 'intervention with an average total Standard Score of 9.13 (SD 2.42). Following intervention there was no significant change in MABC-2 scores  $p=0.25$  (post intervention total Standard Score 8.83, SD 1.47).

**Conclusion:** The current data indicates that this group of overweight/obese adolescents do not present with motor impairments or that participation in the group produces any changes in motor performance. This may indicate that potential participants with motor impairments are not willing to participate in the study or are not being identified by current recruitment strategies. The results may also reflect that the program has not been designed to specifically target motor coordination but confidence, strength and fitness, all of which have also been measured.

#### Poster 94

##### **Bicycle riding for children with DCD: effects on fitness and self-efficacy**

Featherstone Jenny<sup>1</sup>, Campbell Lorna<sup>2</sup>

<sup>1</sup>Sheffield Children's NHS Foundation Trust, Sheffield, United Kingdom, <sup>2</sup>Sheffield Hallam University, Sheffield, United Kingdom

**Background:** Children with Developmental Coordination Disorder (DCD) have difficulty mastering motor tasks. This impacts on participation in physical activity with consequences for fitness, confidence and self-efficacy. Riding a bicycle is a skill which children with DCD identify when setting therapeutic goals.

**Aim:** This study investigated the effect of teaching children with DCD to ride a bicycle on cardio-respiratory fitness and self-efficacy.

**Method:** A single-centre pilot study using a same subject before and after design. Three phases: six week control period, intervention period, six week control period. Intervention was a group designed to teach children with DCD to progress from using stabilisers to riding a two-wheeled bicycle independently.

Cardio-respiratory fitness was measured using the 20m Shuttle Run Test (SRT) and self-efficacy was assessed using the Perceived Efficacy and Goal Setting System (PEGS). Children were assessed at the start of each phase and at the end of phase three. A parent questionnaire was completed at the end of phase three. Participants who met the inclusion criteria were recruited from a therapy waiting list.

Data was analysed using SPSS. Friedman's test was used to compare pre, post and six weeks post bike group SRT metabolic equivalent (MET) mean values and PEGS total score median values ( $p < 0.05$ ).

**Results:** A significant difference was found between PEGS scores ( $p = 0.031$ ) but no significant difference was found between any SRT MET scores ( $p = 0.980$ ). Wilcoxon Signed Ranks Test showed a significant difference ( $p = 0.012$ ) between test 2 and test 4. All parent questionnaires reported continued improvement in cycling ability six weeks after intervention. Participants became more active, more willing to try new activities and more confident.

**Conclusion:** The impact of learning to ride a bicycle on self-efficacy, confidence, activity levels and participation in activities is sustained for at least six weeks. Cardio-respiratory fitness did not improve. Changes in cardio respiratory fitness may be made over a longer time period and a larger scale study is necessary to substantiate these preliminary results.

#### Poster 95

##### **Reducing symptoms among adolescents with DCD by cycling**

Hochhauser Michal

University of Haifa, Haifa, Israel

**Background:** There is strong empirical evidence that the difficulties which experience children with DCD persist into adolescence and adulthood and may lead to the development of secondary physical and mental health and educational issues including poorer physical fitness, poorer social competence, academic problems, behavioral problems, and lower self-esteem.

**Aims:** The aim of this feasibility study was to determine if a recreational cycling program can enhance motor abilities in other areas and improve everyday function among adolescents with DCD.

**Method:** Participants: Four participants ranging from 13 to 18 years who were diagnosed in childhood with DCD participated in this study. They were recruited by acquaintance to the researcher.

Procedure: The participants aged 13-15 were administered the DCDQ and the participants aged 17-18 were administered the Adult Developmental Co-ordination Disorders/ Dyspraxia Checklist (ADC). Two participants rode on tandems outdoors and 2 of the participants rode on stationary bicycles facing a road simulator. All the participants trained 2 or 3 times a week for a period of 8 weeks.

**Results:** The younger adolescents showed improvement in the areas of "Control during Movement" and "General Coordination" on the DCDQ. The older adolescents showed improvement in self care tasks, orientation in space and in desire to spend leisure time with others in the ADC questionnaire. In an interview after the intervention, all 4 participants expressed their desire to continue cycling. In addition,



the participants who cycled outdoors on tandems reported an improvement in self confidence and self esteem.

**Conclusion:** Cycling may improve general motor and coordination abilities among adolescents with DCD. This activity may have positive impact on everyday tasks and reduce additional difficulties.

#### *Poster 96*

### **Effective task oriented intervention (CO-OP approach) with a 7 year old boy with DCD and ADHD: a single case study.**

Rianne Jansens

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DCD is hypothesized as essentially a motor learning disability and treatment should therefore be approached from a skills acquisition or learning perspective, rather than a neuro-developmental perspective (Polatajko, et al., 2001). Due to the poor results from process oriented approaches, since the 90's, several researchers have developed and researched task-oriented approaches with children with DCD. These approaches focus on task performance, viewing motor performance as the interaction of individual, environment and task variables (Cantin & Polatajko in Geuze, 2007; Geuze, Jongmans, Schoemaker, & Smits-Engelsman, 2001; Sugden & Chambers, 1998).

Cognitive Orientation to daily Occupational Performance (CO-OP) is one of these task oriented approaches. 'It is a client-centered, performance-based, problem solving approach that enables skill acquisition through a process of strategy use and guided discovery' (Polatajko & Mandich, 2004, p. 2).

**Aims:** To provide a boy of 7;0 year diagnosed with DCD and ADHD with evidence based occupational therapy by intervention with the CO-OP approach.

To research the possible outcomes of this intervention.

**Method:** Descriptive single case study (Yin, 2009)

**Results:** Over a period of 10 months the child with 7 hours of occupational therapy intervention in the home situation the child improved on 6 motor skills e.g., playing soccer, going to the toilet, roller blade, tying shoe laces, skateboarding, handwriting. Homework was important to elicit generalization and transfer.

During the presentation the characteristics of the CO-OP intervention will be shared. This case study will bring on some reflections towards this task-oriented approach.

#### *Poster 97*

### **Play and social participation of preschool children with DCD: Preliminary findings**

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**Background:** Play provides opportunities for young children to explore their environments and develop a range of skills. It is not yet known whether the play of young children with DCD is any different from that of their peers.

**Aims:** To examine play behaviours and frequency of engagement in preschool children between the ages of 4-6 years with and without DCD.

**Method:** Eleven children with probable DCD and 10 comparison typically developing children participated. Group status was determined using the Developmental Coordination Disorder Questionnaire - German (DCDQ-G) 1 and the German Movement Assessment Battery for Children -2 2. The children were videoed during free play at preschool over two 15 minute periods. Children's play skills and behaviours were scored using the Revised Knox Preschool Play Scales (RKPPS) 3 and the Play Observation Scale (POS) 4.

**Results:** Significant differences were found in the overall play age ( $U = 24.00$ ,  $z = -2.192$ ,  $p = .028$ ) and in the domains of space ( $U = 18.50$ ,  $z = -2.620$ ,  $p = .008$ ) and material management ( $U = 26.50$ ,  $z = -2.011$ ,

p= .045) of the RKPPS. Children with probable DCD demonstrated a lower play age than comparison children. Children with probable DCD had negative affect more often (U=19.00, z= -2.569, p= .009) and were more frequently involved in an aggressive incident, either as victim or aggressor (U= 26.50, z= -2.143, p= .034). These children were also more frequently onlookers rather than players (U= 14.00, z=-2.897, p=.003) and spent more time in transition than in actual play (U= 26.50, z= -2.015, p=.044).

**Conclusion:** Preschool children with probable DCD engage in different types of play behaviour with lower frequencies from an early age. Further research with a larger sample size is currently underway.

### *Poster 98*

#### **The relationship between self-worth and perceived social support in children with DCD and Attention-Deficit Hyperactivity Disorder**

Jacqueline Williams<sup>1</sup>, Carmen Pace<sup>2</sup>, Peter Anderson<sup>3</sup>, Alasdair Vance<sup>4</sup>

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**Background:** Research supports the suggestion that children with either DCD or ADHD are likely to have lower self-worth, particularly when the two occur together. It has also been shown that children with both disorders perceive themselves to have less social support than their peers do. Research is yet to identify how this perceived lack of social support affects the global self-worth of children with DCD+ADHD.

**Aims:** Examine relationships between global self worth, domain-specific self-perceptions and perceived social support in children with DCD+ADHD, ADHD alone and typically developing children.

**Method:** Children aged 7-12 years ? ADHD (N=16), DCD+ADHD (N=16) and Comparison (N=20) ? completed the Harter's Self-Perception Profile for Children and Social Support Scale for Children.

**Results:** There were no differences among groups for global self-worth or the domain-specific self-perceptions, and there was only one difference in perceived social support - the DCD+ADHD group scored significantly lower than comparisons for parent support. Interestingly, the relationships between self-perceptions and perceived support with self-worth varied considerably among groups. For the DCD+ADHD group, perceptions of physical appearance and behavioural conduct correlated with self-worth at a moderate-strong level, whereas for the ADHD group, only physical appearance was strongly correlated with self-worth. Self-worth in the comparison group was correlated strongly with a number of the domains, with the exception of athletic competence.

Perceived social support correlated strongly with self-worth for the ADHD group, but the same correlations were low-moderate in the DCD+ADHD group. Parent and classmate support correlated most strongly with self-worth in the comparison group.

**Conclusion:** The notable differences in the relationship between self-worth and self-perception and perceived social support highlight the fact that self-worth may be shaped differently in children with developmental disorders compared to typically-developing children. Further research is required to elucidate these findings further. Recruiting of a sample of children with DCD alone is underway and we expect to include their results at the conference to further clarify these findings.

## Thursday 23 June, oral presentations at Auditoire Yersin

### Addressing lack of awareness and knowledge of DCD: Results and implications of a public marketing survey

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**Background:** Lack of knowledge of Developmental Coordination Disorder (DCD) results in the misallocation and waste of resources within the healthcare system, challenges for public education, and stress on families. Raising awareness and knowledge of DCD may facilitate more effective and efficient supports and strategies for these groups. More attention to this condition may result in more accurate identification, alleviating some of the healthcare costs and family stresses associated with difficulties in obtaining a diagnosis. It may also ameliorate some of the academic, social and psychological sequela that often accompanies unrecognized DCD in the child.

**Aims:** The objectives of this Canadian project are to raise public and professional awareness of DCD, to identify the most effective diagnostic processes and service delivery models that will improve the prognosis of children with DCD, and to inform stakeholders of these evidence-based strategies.

**Method:** An online public survey from the Canadian National Panel will be used to identify awareness and knowledge of DCD among physicians (n=200), parents (n=500) and teachers (n=400). An additional online survey and in-depth interview will be completed by physicians (n=100), parents (n=200), educators (n=100) and therapists (n=225) who have experience with DCD, to gather information on their perceptions on strategies that would most effectively support children with DCD.

**Results:** An online public survey from the Canadian National Panel will be used to identify awareness and knowledge of DCD among physicians (n=200), parents (n=800) and teachers (n=400). An additional online survey and in-depth interview will be completed by physicians (n=100), parents (n=200), educators (n=100) and therapists (n=225) who have experience with DCD, to gather information on their perceptions on strategies that would most effectively support children with DCD.

**Conclusions:** This public survey is one step in an in-depth analysis of the best practices and best future approaches for effective support for DCD.

### Identification and prevalence of four-year-old Australian children at risk for DCD

Elizabeth Pridham<sup>1</sup>, Susan Hillier<sup>1</sup>, Adrian Esterman<sup>1</sup>

<sup>1</sup>University of South Australia, Adelaide, Australia

**Background:** Children have been typically identified with DCD from five years of age. However earlier identification may facilitate children's engagement with support and prevent secondary effects.

**Aims:** To establish the prevalence of four year old Australian children at risk for DCD. To determine the accuracy of the Children's Activity Scale Questionnaire (ChAS) and teachers' categorical rating to predict risk for DCD.

**Method:** Four year old preschool children in Adelaide, an Australian state capital were recruited. Parents completed the ChAS questionnaire (ChAS-P) in which they rated their child's functional motor skill performance. Socio-economic status was established from the parents' home postcodes. Subsequently, each child's teacher completed the ChAS questionnaire (ChAS-T) and categorically rated

the child's motor skill status. Children whose ChAS-P or ChAS-T score was in the at risk for DCD category were assessed using the Movement Assessment Battery for Children (MABC). Prevalence of children at risk for DCD was determined by MABC scores below the 15th percentile and likely to have DCD below the 5th percentile.

**Results:** Participants were 446 children from 81 preschools. The boy: girl ratio of the sample was 54.5:45.5% compared with 51.5:48.5% for four year old Australian children (ABS 2009). The sample's mean socioeconomic status score (SEIFA) was 964.6 (SD 65.4) (Australia 977.20 (SD 82)). Prevalence of children with at risk for DCD scores was 16.2% (ChAS-P: MABC) and 16.1% (ChAS-T: MABC). Prevalence of children likely to have DCD was 6.8% (ChAS-P) and 5.9% (ChAS-T). Identification of children's MABC scores by ChAS-P had sensitivity 91% and specificity 66% and ChAS-T 86% and 74% respectively. Teachers' ratings of definite and possible motor skill difficulties accurately identified 77% of children at risk for DCD.

**Conclusion:** The 6-7% prevalence is similar to the accepted school-age prevalence while the 16% prevalence may reflect preschool children's differing levels of experience. The ChAS is more accurate than teachers' categorical rating as the identification process's first step.

## **The Movement ABC-2 Checklist: an item analysis and examination of construct validity**

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**Background.** The Movement Assessment Battery for Children (M-ABC) is one of the most widely used assessments in the field of Developmental Coordination Disorder (DCD). The second edition (Movement ABC-2; Henderson, Sugden & Barnett, 2007) includes a revised Test and Checklist. The Checklist contains items describing everyday motor tasks performed in the home and school environment. These tasks are divided into two sections, one focusing on tasks performed in a static environment and one on tasks where the environment is moving/unpredictable. As part of the M-ABC-2 standardisation, the Checklist was revised and shortened and data gathered from class teachers of a stratified sample of 388 children in the UK aged 5-12. In clinical settings, the Checklist is also being used to seek the views of parents.

**Aims.** (i) To explore the usefulness of individual items of the M-ABC-2 Checklist in different contexts and (ii) to examine the factor structure of the Checklist.

**Method.** Data from the 2007 UK standardization sample (n=388) were used in this study. An item analysis was performed to examine the effectiveness of each individual Checklist item across the whole group and for those children with a total score below the 15th percentile. Factor analysis was employed to explore the relationship between the tasks within the motor component.

**Results and conclusion.** The contribution made by each item and section of the checklist to the total score is reported, as well as the relationships between them. The factor structure is discussed in relation to the present division of the motor items into two sections.

## Assessment of activities of daily living in children with DCD - Psychometric properties of a new test: the DCDDaily

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**Background:** Children with Developmental Coordination Disorder (DCD) experience difficulties in learning and performing Activities of Daily Living (ADL). Difficulties in performing ADL are part of the diagnostic criteria for DCD and form an important target for intervention. Strikingly, an objective and systematic method for assessment of ADL is lacking.

**Aim:** In order to realise optimal diagnosis and intervention for children with DCD, the aim of this study was to develop a valid and reliable instrument for the assessment of children's ADL performance.

**INSTRUMENT:** The DCDDaily is a new instrument to physically assess children in their ecological environment, with a representative set of ADL, comprising of the three ADL domains; self-care and self-maintenance, productivity and schoolwork, and leisure and play.

**Methods:** Children (aged 5 to 8 years) with DCD (n=46) and typically developing (TD) children (n=210), were assessed with the DCDDaily, as well as the Movement Assessment Battery for Children-2 (MABC), the MABC-checklist, the DCDQ, and the DCDDailyQ (parental questionnaire that was designed in addition to the DCDDaily).

**Results:** Initial results show the DCDDaily to be discriminative, with mean scores of children with DCD and children TD differing significantly ( $Z=-4.0$ ;  $p<0.001$ ). Concurrent validity was found satisfactory, (MABC:  $r=-0.68$ ; MABC-checklist:  $r=0.34$ ; DCDQ:  $r=-0.36$  ( $p<0.001$ )). Internal consistency of the DCDDailyQ was confirmed (Cronbachs  $\alpha$  0.871).

**Conclusions:** Initial results show the DCDDaily to be valid and reliable. The DCDDaily provides an objective and systematic picture of ADL performance, which is helpful to optimise diagnosis and intervention of children with DCD. During the coming year, another 50-100 children will be assessed. Definite results on psychometric properties of the DCDDaily, as well as norm scores, will be presented at the conference.

## Movement skill characteristics of preschool children referred to a clinical service

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**Aims:** Increased interest in DCD has corresponded with increased referrals particularly for preschool children. Diagnosis is rarely given before 5 years of age and very little is known about the early characteristics/predictive validity of movement difficulties which may place a young child at risk of DCD. This study aims to determine the accuracy of referrals and obtain preliminary information regarding characteristics of movement difficulties which may provide important indicators of children at risk of DCD in the preschool population.

**Method:** Cross Sectional Study utilising a convenience cohort of children 4y0m-6y10m referred to a regional child development centre for concerns over motor development in the absence of known neurological or cognitive pathology. Comprehensive clinical assessments included measures of fundamental motor skills (Movement Assessment Battery Children-2 (MABC2); Bruininks Oseretsky Test-2 (BOT2)) and questionnaires of functional performance, behaviour and medical examination (and cognitive assessment for those suspected of having DCD).

**Results:** Data collection is ongoing. Results to date show 17/49 to have movement difficulties below the 15%ile according to the MABC2 (33.3%; range 0.5%ile to 99.5%ile) and 17/40 children to fall below the 15%ile on the BOT2 (43%; range 0.5%ile to 99%ile) whilst only 9/40 (23%) of these children fell below the 15%ile on both scales. Demographic, birth and referral characteristics will be reported. Analysis of the relationship between fundamental motor skills (e.g. fine motor, ball skills, balance) and functional tasks (e.g. self-care, desk skills, recreational skills) will be undertaken. Logistic Regression analyses will be used to identify significant assessment variables predictive of probable DCD.

**Conclusion:** Identifying and characterising movement skill deficits in pre-school children at risk of DCD is an important step towards the identification of predictor variables which may indicate persistence of movement problems and the need for treatment. The results of this study will be presented at the conference.

## **Longitudinal assessment of psychological distress in adolescents with developmental coordination disorder**

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**Background:** Psychological distress (PD) is often used to describe the presence of symptoms of depressed affect and anxiety that while significant, may not necessarily be associated with clinical disorder. Existing research suggests that children with DCD are at greater risk for social, emotional and behavioural problems, including depression and anxiety, when compared to their typically developing peers, and are therefore at risk for PD. However, there is a paucity of longitudinal data in which both DCD and PD are repeatedly assessed in the same children over time.

**Aims:** To examine change in PD in children with probable DCD (pDCD) and typically developing children over time.

**Method:** A case-control study was conducted with children with pDCD and typical peers (non-DCD). Children were followed for 3 years, from ages 12 to 15 (n=86). PD was assessed in years 2 and 3 using the Kessler 6 (K6) scale. Children were assessed for motor coordination problems each year, and categorized as cases of pDCD using the Movement Assessment Battery for Children, 2nd Edition (M-ABC-2). Cut-points at both the 5th (pDCD-5; n=21) and 16th percentiles (pDCD-16; n=17) were used for this analysis, based on their average scores over the 3-year period.

**Results:** A significant effect for time ( $p=0.001$ ) and a group by time interaction ( $p=0.023$ ) were observed for K6 scores. Specifically, the observed change in K6 scores from years 2 to 3 was greater in the pDCD-5 group (12.24 to 9.43) than those observed in the pDCD-16 (11.06 to 10.76) and non-DCD groups (10.06 to 9.25) (Tukey HSD; pDCD-5 vs pDCD-16,  $p=0.039$ ; pDCD-5 vs non-DCD,  $p=0.041$ ).

**Conclusion:** To our knowledge, this is the first study assessing both PD and motor coordination in children with DCD longitudinally. These results suggest that levels of PD change over time among children with pDCD. Future research should examine this paradoxical decrease in PD among adolescents with DCD who have the greatest motor difficulties.

## Individual differences in IQ profiles of children and adults with DCD

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**Background:** Developmental Coordination Disorder (DCD) is diagnosed typically in those whose 'measured intelligence' is commensurate with their chronological age. However, within this, it seems likely that different profiles of strength and weakness exist between individuals. Furthermore, IQ testing has typically been reported in children, and not adult DCD samples.

**Aims:** To investigate the individual profiles of both children and adults with DCD, paying particular attention to the pattern of relative peaks and troughs in performance (noting that these will always fall within the normal range of the IQ test).

**Method:** In two separate studies, 34 children and 15 adults with DCD were compared to their typical peers on various subtests of the appropriate Wechsler intelligence test batteries. Group scores were compared, although the key focus was on individual difference analysis within and between the groups.

**Results:** All participants had standardised scores on all test components within the normal range. Verbal IQ scores were well matched between the clinical and comparison groups at both age groups. As a group, adults with DCD had significantly lower standardized scores on the perceptual organization subtests of the WAIS, but showed similar levels on the verbal comprehension and working memory indices. Group differences were identified in the child sample only on the processing speed index. Individual profiles across the subtests revealed varying patterns of performance rather than one common pattern.

**Conclusion:** Individual differences exist in the detailed IQ profiles of children and adults with DCD. Identifying the IQ profile of those with DCD should not be taken as a substitute for careful diagnosis based on full DSM criteria. However, understanding IQ profiles may suggest reasons for likely subgroups, as well as for performance on experimental tasks and co-occurrence of motor difficulties across developmental disorders.

## Motor, cognitive and behavioral differences between children with severe motor difficulties and moderate motor difficulties.

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**Background:** According to Criterion A of the DSM-IV-TR the motor skills of children with DCD are below that expected for their age. It is recommended to administer a motor test to investigate whether children meet Criterion A. However, how severe the motor difficulties need to be to meet criterion A is still a matter of debate. In the Leeds Consensus Statement, the 5th centile was accepted as cut-off criterion, but in the recently developed European Guideline for DCD, the 15th centile has been recommended. The decision to use either the 5th or the 15th centile has been made on statistical grounds, but is not empirically grounded by research findings.

**Aim:** To investigate whether children with moderate motor difficulties (scores between the 5th and 15th centile on a coordination test) are less impaired than children with severe motor difficulties (scores below the 5th centile on a coordination test) on measures of ADL, behavior (attention, social communication) and IQ.

**Method:** Data from the Avon Longitudinal Study of Parents and Children (ALSPAC) population based

study were used to answer this question. In the ALSPAC study, 7,058 7 to 8 year old children were assessed with the ALSPAC coordination test, which was derived from the Movement Assessment Battery for Children. With this test, 324 children were identified as children with severe coordination difficulties (scores below 5th centile), and another 975 children were identified as children with moderate coordination difficulties (scores between 5th and 15th centile). Data regarding ADL, IQ, short-term memory and behavior (attention, social communication) were gathered.

**Results/Conclusion:** Results will be presented at the conference, and implications for clinical practice will be discussed.

## **Are scholastic skills impaired in children with motor coordination problems?'**

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**Background:** Studies reveal about 50% of the children with motor coordination problems or Developmental Coordination Disorder to have a co-morbid learning disability. However, mostly no distinction has been made between the different learning disabilities. With disregard of reading problems, respectively few or no studies have examined the co-morbidity of spelling and mathematical problems in children with different degrees of motor coordination problems.

**Aim:** This study aimed to investigate reading, spelling and mathematical skills in children with motor coordination problems.

**Method:** Hundred and ten children with a score  $\leq$  percentile 5 on the M-ABC 2 (severe motor coordination problems), 104 children with a score between percentile 6 and 16 (mild motor coordination problems) and 90 age-matched control children (a score  $\geq$  percentile 25) participated in this study. All 363 children were at least of average intelligence and were assessed with Dutch standardized tests for reading, spelling and mathematics (number fact retrieval, procedural calculation and geometry).

**Results:** ANOVA's revealed that children with severe motor coordination problems obtained significantly poorer scores on measures of reading, spelling and mathematics in comparison with the control group. Children with mild motor coordination problems scored significantly poorer than control children for spelling and procedural calculation. In addition, children with more severe motor coordination problems performed significantly worse on reading and mathematics compared with children with milder motor coordination problems.

**Conclusion:** Children with motor coordination problems are often at risk for additional scholastic, problems. Our data underline the need for testing reading, spelling, number fact retrieval, procedural calculation and geometry in the assessment of children with motor coordination problems in order to develop a STI(mulation), CO(mpensation), R(emediation) and DI(spensation) advice based upon the specific needs of each child.

## **Planning and organizational abilities among adults with DCD**

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**Background:** There is increasing evident that children with DCD do not "grow out" of their difficulties thus the impact of DCD is continuing into adulthood. However, the literature about the functional every day characteristics of those adults is scarce.



The **aim** of the study was to characterize planning and organization abilities of students with DCD in comparison to that of students with typical development,

**Method:** 30 students ages 24-41 years who were diagnosed with DCD or who self-reported as having motor impairments consistent with a history of DCD, and 30 age- and gender-matched controls participated in the study.

They performed two tasks of the Behavioral Assessment of the Dysexecutive Syndrome (BADs) and wrote their agenda on a digitizer which was part of a computerized system (ComPET). Further they filled in the Adult Developmental Co-ordination Disorders/Dyspraxia Checklist (ADC), the Time Organization and Participation questionnaire (TOPS), and replied for two questions about their satisfaction from their every day function.

**Results:** Significant differences were found for the temporal, spatial and pressure measures of the BADs and writing tasks as supplied by the ComPET. Significant differences between groups were also found for the TOPS and ADC domains.

Series of regression analysis indicated that several objective measures of the BADs and the agenda writing task explained 52% of the organization in time abilities (TOPS) and 37% of DCD symptoms level (ADC). Furthermore, certain measures of the BADs tasks, the TOPS and the ADC final scores explained 76% of overall ability to function as reported by the participants.

**Conclusion:** those study results indicates the importance of considering planning and organization abilities among adults with DCD both in evaluation and intervention process with this population

## Exposure to second-hand smoke during pregnancy and DCD

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**Background:** The cause of DCD is not yet understood; however, it is known that children with DCD are more likely to have other, co-occurring developmental disorders such as ADHD, and various learning disabilities. While there is a growing body of evidence linking these other problems to second-hand smoke (SHS) exposure while in utero, there is limited evidence that SHS exposure during pregnancy is related to DCD.

**Aims:** To examine the association between SHS exposure in utero and the occurrence of DCD.

**Method:** A case-control study was conducted to study the differences between children with probable DCD (p-DCD) and typical peers. Participants included 63 p-DCD children and 63 healthy controls at baseline. All children were assessed for motor proficiency using the Movement Assessment Battery for Children, 2<sup>nd</sup> Edition. A parent (or primary caregiver) of each child completed a medical academic history questionnaire from which mother's SHS exposure during pregnancy, child's birth weight, and total household income (SES) were obtained. Linear regression was used to examine the main effects of SHS exposure, birth weight, and household income on the development of DCD.

**Results:** When using the 16<sup>th</sup> percentile cut-off on the M-ABC-2 to define p-DCD, the results indicate that children exposed to SHS in utero are 2.3 times more likely to develop DCD than children who were not. After adjusting for birth weight and household income, children are 2.2 times more likely to develop DCD if exposed to SHS in utero. When using the 5<sup>th</sup> percentile to define p-DCD, the chances of having DCD increase to 2.9 times and 3.4 times (after adjustment), respectively.

**Conclusion:** The results suggest that exposure to SHS during pregnancy has a negative effect on fetal development and increases the chances of the child developing DCD. The association between SHS and DCD is not influenced by household income or birth weight. Further research is needed to examine the mechanisms linking SHS exposure to motor coordination problems in children.

# Friday 24 June, oral presentations

## at Auditoire César-Roux

### Neural mechanisms of motor overflow in children with DCD: a functional MRI study

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**Background:** Previous research has shown that children with DCD display increased motor overflow accompanying the performance of voluntary movements, potentially reflective of deficits in inhibitory control.

**Aim:** To investigate this, the present study examined cortical activation patterns on a sequential finger sequencing task using functional MRI.

**Method:** Twenty-six male children participated in this study, 13 with DCD (mean age = 9.6yrs + 0.8) and 13 typically developing controls (mean age = 9.3yrs + 0.6). Prior to scanning, children were tested on the MABC-2, with children in the DCD group <5th percentile (Mean = 1.7, SD = 1.6) and controls >15th percentile (Mean = 46.2, SD = 18.1). In addition, children were familiarized with the scanning protocol during this session. MR imaging was conducted on a 3T Philips Achieva TX scanner using an 8 channel head coil. High resolution anatomical images were acquired first (T1-weighted 3D FFE 160 slices 1x1x1 mm), followed by two functional studies (T2-weighted gradient echo, TR/TE = 3000/35ms, flip angle 90°, 24 axial slices with a thickness of 4mm, no gaps). A randomized block design was employed with two active tasks (finger sequencing and hand clenching) performed on their dominant hand. Visual and auditory stimuli were used to prompt and coordinate each task. Active tasks (27 sec) were interspersed with 12 second rest periods. A custom built four-finger motion sensor glove (Mag Design & Engineering) was worn by participants during scanning to record displacement of digits (motor overflow) in their non-dominant hand. Preprocessing and analysis was performed using Brainvoyager QX software (v. 2.1).

**Results:** Consistent with previous research, preliminary results indicate decreased cortical activity, with some areas known to play a major role in the regulation of inhibition.

This study is currently ongoing. Full results will be presented at DCD-IX.

### Attention and motor preparation in adults with DCD: an EEG study

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**Background:** Typical individuals attend task relevant locations (including effector location) during the preparatory phase of a unimanual movement. DCD individuals demonstrate decreased modulation of attention to cued locations compared to typically developing peers, suggestive of atypical attention and executive functioning. However, no research has examined how a DCD group modulates attention during a movement task utilizing EEG measures, which provide temporal markers of cognitive function.

**Aims:** To use ERPs to investigate whether DCD vs. typical adults display similar patterns of attentional

trajectories during the preparatory phase of a ballistic hand movement to target. To our knowledge this is the first study to use EEG measures of movement and attention to examine DCD performance.

**Methods:** 14 adults with DCD and 14 well-matched typical adults completed a go/no go choice reaction time task with concurrent EEG recording. Participants moved the cued effector from the start location to target buttons either in the same hemisphere (ipsilateral condition) or across the body midline (contralateral condition). Measurements included EEG potentials elicited by covert shifts of attention in response to cues, and visual evoked ERPs to covert visual probes presented at cued hand and target locations.

**Results:** In line with previous studies, the behavioral performance of the DCD group was significantly impaired on all measures, including reaction and movement times, effector selection and target button depression errors. Focusing on the EEG data, during the contralateral condition the DCD group demonstrated a (1) decrease in probe locked spatially specific discrimination, evident by the enhanced N1 component at opposite target location; (2) significantly decreased hemi by cue ADAN effect at frontal electrode sites during both movement conditions. LDAP enhancement between ipsilateral and contralateral conditions was seen in the Control, but not the DCD group.

**Conclusion:** This interesting pattern of results may reflect a unique motor selection process in the DCD group or altered preparation strategies for movements with differing spatial parameters.

## **The relationship between the development of movement skill, online control and executive control in children: a longitudinal investigation**

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**Background and Aims:** This paper reports on the findings from the first stage of a longitudinal study of the relationship between online control, movement skill and executive function in primary-school aged children. The study is unique in addressing the hypothesis that (i) (non-linear) age-related changes in rapid online control (which relies on predictive estimates of limb position) are constrained by the unfolding of frontal executive control, and (ii) many children with DCD manifest a core deficit in predictive control.

**Method:** Tested at Time 1 were 144 children aged between 6 and 11 years (or 24 per age level), as well as 20 children with severe DCD. All children were attending mainstream schools. The motor ability of all children was assessed using the MAND. Online control was tested using a double-step reaching task and executive function by the Groton Maze Learning Task (GMLT) and anti-reaching task.

**Results:** Mixed-model analysis showed progressive age-related changes in performance on the double-step reaching task; with age, movement time on jump trials was faster and time to correction occurred earlier. Children with DCD were more disadvantaged on jump trials and showed later corrections, much like the performance of the younger age group. Similar age trends were shown for anti-reaching, with movement time and errors decreasing with age. Crucially, there was a relationship between markers of online control and executive function. Younger children (and DCD) who demonstrated less developed online control also experienced difficulty inhibiting movements toward a compelling yet inappropriate stimulus.

**Conclusion:** The pattern of responses indicates that the maturation of executive function may influence the mode of online control and motor prediction that is enlisted over the course of childhood. Implications of these data for models of DCD are discussed. We anticipate that by May next year a 6-month follow-up will be complete (viz Time 2), further clarifying the pattern of developmental change we have already observed cross-sectionally.

## Impaired online control in children with DCD reflects developmental immaturity

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We recently showed that online control is compromised in DCD. Poor performance during double-step reaching (i.e., slower movement on jump trials and delayed correction time) suggested a reduced capacity for predictive modelling (Hyde & Wilson, 2010). It remains unclear whether this profile reflects immaturity or deviance from a typical developmental path. The present study aimed to clarify this issue by comparing the double-step reaching of children with DCD with age-matched and younger controls. A group of young adults served as a benchmark for mature movement.

Participants were 18 children with DCD (8-12 years), 18 age-matched controls, 12 younger controls (5-7 years) and 14 young adults (18-28 years). Participants reached and touched a target presented at one of three locations on a 60cm touchscreen. For 80% of trials, the central target remained stationary. For the remaining trials, the target shifted laterally at movement onset.

The speed with which typically developing individuals were able to adjust for target perturbation increased with age. Chronometric data showed children with DCD (and younger controls) were significantly slower to complete jump trials than age-matched controls. Kinematic analysis failed to differentiate DCD and age-matched controls on early markers. However, children with DCD (like younger controls) were significantly slower to correct their reach trajectory.

Taken together, these results confirm that children with DCD have a reduced ability to make rapid online adjustments, suggesting disruption to predictive control mechanisms. This difficulty appears to mirror the pattern of performance shown by younger children, suggesting a developmental delay or immaturity, possibly at the level of posterior parietal cortex.

## Impaired visuo-motor sequence learning in children with DCD

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**Background:** The defining feature of Developmental Coordination Disorder (DCD) is the marked impairment in the development of motor coordination. One important aspect of motor coordination entails the correct sequencing of movements. Learning sequence information is crucial for efficient and fluent behaviour, i.e., based on the sequence knowledge, one can adequately predict the upcoming event and actions can be planned in a feedforward manner.

**Aim:** Although sequence learning is of crucial importance for efficient motor coordination, it has rarely been studied in the DCD population. In the current study, we therefore investigated the procedural, visuo-motor sequence learning abilities of 18 children with DCD and 20 matched typically developing (TD) children.

**Method:** Participants performed the Serial Reaction Time (SRT) task over 6 blocks of 100 trials. During the SRT task, participants have to react as fast and as accurately as possible to the location of a visual stimulus on the computer screen by pressing the corresponding response key. During the first 4 blocks of SRT performance, the succession of the stimuli and responses follows a repeating sequence structure. Then, to test sequence learning, on the fifth block the repeating sequence is interrupted by an unpredictable, random succession of stimuli and responses.

**Results and Conclusions:** Statistical analyses on reaction time measurements yielded two important findings. Overall, DCD children demonstrated general learning of visuo-motor task demands

comparable to that of TD children but failed to learn the visuo-motor sequence. Interestingly, a sequence recall test, administered after the SRT task, indicated some awareness of the repeating sequence pattern. This suggests that the sequence learning problems of DCD children might be located at the stage of motor planning rather than sequence acquisition.

## **Optimal timescales for visuomotor control in DCD**

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**Background:** Previous studies on goal-directed actions have shown that the processing of emergent, dynamic information across different timescales is crucial for well-coordinated goal-directed actions. Different neural networks are believed to handle short-term information for the correction of errors (cerebellar) and longer-term action preparation based on spatial layout and spatial updating (parietal networks). It has been proposed that the problems exhibited in developmental coordination disorder (DCD) may be due to a cerebellar deficit, or may be due to dorsal stream vulnerability (including parietal networks) though there is a paucity of evidence to support either hypothesis. This work suggests that any complex motor task that benefits from prospective control will require the interaction between dorsal stream and cerebellar networks.

**Aims:** In two studies, we examined the hypothesis that DCD consists of a poor integration of visual information across timescales.

**Method:** Participants, who were young adults with DCD, used a steering wheel to steer through virtual winding roads with specially designed configurations. In different conditions and experiments we manipulated the duration and timing of the information displayed. We analysed the gain and phase of the steering response in respect to the stimuli-road presented.

**Results:** When information on either timescale was displayed in isolation the DCD group performed similarly to the control group. The DCD group, however, showed difficulties in integrating the different streams of visual information for planning and online control. In a follow-up study the control group benefitted monotonically from longer information whereas for the DCD group performance was optimal at 500 ms and 750 ms with decrements at shorter and longer timescales.

**Conclusion:** Young adults with DCD show unimpaired performance in the use of short-term visual information for the online control of actions. However, when visual information is available across different timescales their performance deteriorates.

Keywords: Neuroimaging; Perceptual motor coordination; Mechanism

## **Postural responses of DCD and TDC children to tasks demanding perceptual and cognitive effort**

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**Background:** Previous studies have employed a supra-postural task paradigm to investigate differences between DCD and TDC children. No research has investigated changes in postural responses when comparing the demands of a perceptual task to a cognitive task.

**Aims:** This study investigated the effect, on both DCD and TDC children, of varying visual (perceptual) and memory (cognitive) demands on postural motion.

**Method:** Sixty four children (32 DCD, 32 TDC, 9-to-10 years) were volunteers. They performed

separate visual and memory tasks each with two levels of difficulty (Easy and Hard) while their postural motion was recorded as variability of postural sway.

**Results:** Both DCD and TDC children dampened postural sway in the Hard level of the memory task; in the visual task, requiring perceptual effort, responses were different. The TDC children reduced their postural sway in the Hard condition of the perceptual task, DCD children were unable to reduce their postural sway.

**Conclusion:** A memory task requiring cognitive effort shows no group differences ; for a visual task requiring perceptual effort the pattern of sway is different between groups. The DCD group were unable to reduce their postural sway and in fact their postural motion increased. In the same condition the TDC group reduced their postural sway as they did in the corresponding cognitive task. This suggests a weakening in the perception 'action link in children diagnosed with DCD. The data are discussed in the context of a limited perceptual ability that is reflected in their motor difficulties.

Key words: Perceptual- motor coordination, Motor control and analysis.

## **The effect of task and individual constraints on affordances for walking in children with DCD**

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**Background:** Limited research has examined the perception of affordances in children with Developmental Coordination Disorder (DCD). Furthermore, how perceptual and actual judgments of capabilities in these children differ as function of task complexity has received no attention.

**Aims:** To evaluate the ability to accurately perceive action capabilities in a clinical sample of children with DCD (DCDc) and in a school based sample of children identified as being at risk for DCD (DCDs), and compare this to actual action capabilities during a walking task of differing complexities.

**Method:** Twenty children (7-8 years) with DCDc (N=8) or were considered at risk of DCDs (N=12) and TDC participated in the present study. Four experimental manipulations were used to assess performance in a perceptual and action judgment task of walking. (1) Walking an uncluttered 5m walkway (2) Walking an uncluttered 5m walkway holding a beaker containing 150ml of liquid (3) Walking a 5m walkway whilst stepping over barriers (4) Walking a 5m walkway whilst stepping over barriers holding a beaker containing 150ml of liquid. The order of tasks was randomised and counterbalanced across participants.

**Results:** Children with DCD consistently underestimated the number of steps it would take them to complete the walking task and this was more evident in tasks of increasing complexity (tasks 4 & 5), when actual action capabilities were measured compared to perceptual judgments and in children drawn from a clinical sample ( $p<.005$ ).

**Conclusion:** Compared to TDC, children with or at risk of DCD made less accurate judgments about their action capabilities, this is exacerbated in children drawn from a clinical sample and when the task complexity increases. This study also suggests that making verbal judgments about affordances is a different task to actually acting on them. Data from the present study has implications for future study design and intervention.

## Are motor imagery deficits evident in children with both Developmental Coordination Disorder (DCD) and Attention-Deficit Hyperactivity Disorder?

Jacqueline Williams<sup>1</sup>, Cristina Omizzolo<sup>2</sup>, Alasdair Vance<sup>3</sup>

<sup>1</sup>Victoria University, Melbourne, VIC, Australia, <sup>2</sup>La Trobe University, Melbourne, VIC, Australia, <sup>3</sup>Royal Children's Hospital, Melbourne, VIC, Australia

**Background:** While the motor impairment observed in children with ADHD is similar to that seen in DCD physically, it is unclear whether the underlying mechanisms are the same, with some arguing the motor impairment in ADHD is linked more to attention deficits.

**Aims:** To examine whether motor imagery deficits previously observed in children with DCD are also present in children with ADHD+DCD, extending previous work by taking into account IQ and attention. **Method:** Children aged 7-12 years ? ADHD (N=16), ADHD+DCD (N=16) and Comparison (N=20) ? completed an IQ assessment and two motor imagery tasks ? the Visually Guided Pointing Task and the Hand Rotation Task. Parents completed the Conners' Parent Rating Scale to provide a measure of attention.

**Results:** The two ADHD groups had significantly lower scores for attention, but there were no differences between the ADHD groups. The ADHD-DCD group had significantly lower IQ scores than the remaining groups, which did not differ. Like their peers without motor impairment, the ADHD+DCD group showed speed-accuracy trade-offs in both real and imagined movements during the pointing task. However, the difference between real and imagined movements was greater in the ADHD+DCD group compared to others, falling just short of significance ( $p = .06$ ). There were no group differences in response time for the hand task, but there was a group difference for accuracy ( $p = .029$ ), with the ADHD+DCD group the least accurate.

**Conclusion:** Children with ADHD+DCD show some of the same deficits on motor imagery tasks as children with DCD alone, which cannot be attributed to attention or IQ. This supports the stance that motor deficits in ADHD are not caused by reduced attention levels. Recruiting of a sample of children with DCD alone is underway and we expect to include their results at the conference to further clarify these findings.

## The effect of visuo-motor complexity on movement in children with varying motor abilities

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<sup>1</sup>University of Toronto, Toronto, Canada

**Background:** It is well documented in the literature that children with Developmental Coordination Disorder (DCD) experience difficulties when performing activities requiring the coordination of eye and hand movements. Skilful performance of such activities requires visuo-motor transformations that map motor commands onto visual consequences or transform a desired visual consequence into the motor command to achieve it. In adults and typically developing children, it has been demonstrated that visuo-motor transformations of increasing complexities affect movement planning and execution. The relationship between the effect of complexity of visuo-motor transformation and motor difficulties has not been systematically explored in children with motor deficits.

**Aim:** To examine the relationship between the effect of increasing complexity of visuo-motor transformations on movement and children's motor abilities.

**Methods:** Children with varying levels of motor function were recruited and tested on the Movement Assessment Battery for Children (M-ABC). During a computer game, 40 children 8-12 years of age were asked to land a shuttle (cursor) on a planet (target) using three cursor controls representing increasing levels of visuo-motor complexity: a computer mouse, a joystick, and a complex controller combining horizontal and rotational hand movements. A regression analysis was conducted to estimate the degree to which visuo-motor transformation complexity and performance on M-ABC could predict children's motor performance on the task.

**Results:** Preliminary analyses of the data suggest that while there does not seem to be a relationship between performance on M-ABC and performance on the simpler visuo-motor transformations (mouse and joystick), a relationship does exist for the more complex visuo-motor transformation.

**Conclusion:** This study will add to the existing body of literature exploring eye-hand coordination in children with DCD by demonstrating how motor ability affects performance, highlighting the need to consider complexity of visuo-motor transformation when discussing eye-hand coordination tasks.

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## ***Friday 24 June, oral presentations*** ***at Auditoire Auguste-Tissot***

### **Developmental Coordination Disorder and academic performance: a longitudinal study using a large sample of children in a public school setting in Canada**

Scott Veldhuizen<sup>1</sup>, John Cairney<sup>2</sup>, John Hay<sup>3</sup>, Brent Faught<sup>3</sup>

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**Background:** It has been established that motor coordination difficulties affect academic performance.

**Aims:** The extent, frequency, persistence, and specific causes of academic problems in children with DCD are unclear. In the present study, we examine these issues using results of standardized, school-administered academic testing.

**Method:** Data were taken from a large, longitudinal sample of children drawn from regular school classes. Children in special needs classes were excluded. Probable DCD status (pDCD) was defined as a score <5 on the short-form of the Bruininks-Oseretsky test of motor proficiency (BOTMP-SF). These data were linked to results from 2 rounds (grade 3 and grade 6) of standardized testing in reading, writing, and mathematics. 75 pDCD and 1603 typically developing (TD) children had complete data, and 102 pDCD and 1974 TD children at least partial data. Differences between groups were examined using ANOVA, chi-square tests, and regression.

**Results:** Across tests, mean scores for pDCD children were between 81% and 89% of those for TD students (all  $p < 0.001$ ). The proportion failing to meet set standards was higher among pDCD children on all tests (all  $p < 0.001$ ), ranging from 24% (grade 6 writing test) to 44% (grade 3 reading test). On average, 34% of pDCD children and 11% of TD children failed to meet set standards. Differences were unaffected by adjustment for gender differences. Between grade 3 and grade 6, performance declined significantly among children with pDCD, and increased slightly among TD children.

**Discussion:** Many pDCD students in regular classes struggle academically. Deficits are broad and persistent, appearing neither to be focused in any particular area nor to improve with time. Although it is unknown how many of these children would meet criteria for other relevant disorders of childhood, it is clear that academics generally are an area of concern for children with DCD.



## The mediating influence of physical fitness on the relationship between academic performance and motor proficiency

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<sup>1</sup>Brock University, St. Catharines, Canada, <sup>2</sup>McMaster University, Hamilton, Canada

**Background:** Factors that impact scholastic achievement are under close scrutiny given rising pressures to meet academic standards. Research has consistently demonstrated a positive relationship between physical fitness and academic performance. Children with DCD have difficulty in academic performance and are also known to have poor fitness levels. This raises the possibility that the academic difficulties of children with DCD may be exacerbated by poor fitness. However at this point we have little knowledge regarding the interrelationship between motor coordination, physical fitness, and academic performance.

**Aims:** In this investigation we explored the potential mediating influence of physical fitness on the relationship between academic performance and motor proficiency in 11 to 12-year-old children.

**Methods:** The sample consisted of 83% of all Grade Six students (F = 912, M = 929) from 75 of 90 schools in the District School Board of Niagara. Subjects with known disabilities were excluded from analysis, leaving complete data for 1841 subjects with a mean age of 11.91. Academic achievement was derived from average performance on standardized province-wide tests of reading, writing, and math. The rank-percentile on the Bruininks-Oseretsky Test of Motor Performance (short-form) was used to determine motor proficiency. The final stage completed on the Léger 20-m Shuttle Run Test was used to estimate aerobic fitness.

**Results:** OLS regression identified several significant predictors of academic performance. After controlling for age and gender, the main predictor variable ? motor proficiency ( $p < 0.0001$ ) remained significant. After adding physical fitness ( $p < 0.0001$ ) to the model the effect of motor proficiency on academic performance remained significant however the point estimate was reduced by 25% from 0.0043 ( $p < 0.0001$ ) to 0.0032 ( $p < 0.0001$ ).

**Conclusions:** These results suggest that physical fitness plays a mediating role on the relationship between academic performance and motor proficiency although both aerobic fitness and motor proficiency have independent roles in academic performance. Interventions designed to improve the scholastic achievement of children with DCD should consider aerobic fitness as well as the child's motoric challenges.

## Do children with motor deficits accurately predict their action gaps?

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At the roadside, the pedestrian's task is to judge whether there is sufficient time to execute a road crossing action relative to the spatio-temporal gaps between moving vehicles (action gap). Lee (1976) suggests that successfully controlling an action gap is dependent on perceptually detecting the instantaneous optic size ( $\theta$ ) and relative rate of optic expansion ( $\dot{\theta}$ ) of an approaching vehicle, which at constant velocity increases exponentially with time ( $t$ ) and informs the time available to cross ( $\tau$ ): Lee, 1976). However, previous research has found that sensitivity to optic expansion develops throughout childhood (Wann et al, 2011) and is significantly reduced in children with DCD. However, both of these studies measured looming sensitivity rather than the accuracy of children to select sufficient crossing gaps to execute an action. If the time that it takes a pedestrian to cross the road is greater than the available gap then collision will occur, in the current study we measured whether children with motor

deficits accurately select traffic gaps that are greater than their crossing time. Multiple 'vehicles' approaching at speeds of 20mph, 30mph and 40mph in one and two lane conditions were presented on a three-screen display. Using a best-PEST psychophysical procedure with computer 3D generated simulations, we measured crossing gap thresholds and compared them to the estimated crossing gaps required to achieve a safe road crossing. We found that children with motor deficits accepted crossing gaps at all approach speeds that were shorter than the time they would need to cross, potentially placing them at significant risk at the roadside.

## **Changes in self-perception of physical appearance and athletic competence in children with DCD over time**

Divya Joshi<sup>1</sup>, John Cairney<sup>1</sup>, John Hay<sup>2</sup>, Brent Faught<sup>2</sup>

<sup>1</sup>*McMaster University, Hamilton, Canada,* <sup>2</sup>*Brock University, St. Catharines, Canada*

**Background:** Developmental coordination disorder (DCD) is diagnosed in children with impaired motor coordination that is not related to other physical and intellectual disorders. Several studies have found that children with DCD have significantly lower self-perceptions of physical appearance and athletic competence compared to typically developing children. However, the majority of these studies have been cross-sectional in design. This relationship has not been explored using longitudinal data, over a number of years. It is not yet known if negative perceptions of competence in these domains remain stable, diminish or increase as children grow older.

**Objective:** To examine if self-perception of physical appearance and athletic competence in children with DCD and those without remain constant overtime, or change as children age.

**Methods:** Physical Health Activity Study Team (PHAST) data was used for this longitudinal analysis. A total of 2824 (DCD=114) children aged 9-13 years were included in the analysis. Mixed-effects modelling was used to estimate change in self-perception in children over time.

**Results:** Compared to children without DCD, those with DCD score 2.2 and 3.7 points lower on self-perception of physical appearance and athletic competence respectively ( $p<.0001$ ), and this difference remains constant over time. The relationship between DCD and self-perception of physical appearance is curvilinear (convex shaped). BMI and physical activity have a mediating effect on the relationship between DCD and self-perception. Approximately, 72.7% of the association between DCD and self-perception of physical appearance, and 28.3% of the association between DCD and athletic competence is accounted for by BMI and physical activity levels.

**Conclusions:** Differences in self-perception of physical appearance and athletic competence in children with and without DCD remain constant over time. Reduced activity and higher relative body weight are important factors associated with poorer perception of physical appearance.

## **The action-perception dynamic patterns in an accuracy throwing task of school children at risk for DCD**

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This study questioned how primary school children would use environmental variables relating it to action to anticipate their performance, and also whether children with high (HP) and low performance (LP) would differ on these dynamics.

**Method:** Thirty-five primary school children matched by gender, age and observed high and low motor performances (HP and LP) took part in this study, which aimed to examine the coordination dynamics of

action-perception system in children when executing a bean-bag throwing into a box. Throwing distances were scaled to the children's height plus arm lengths added for each of six throwing distances. Children were placed before a limit line, given the bean bag and invited to judge whether, from that location, they could throw the bean bag into the box. After the queries for the six the distances the children made their attempts.

**Results:** Proportions of positive judgments, accurate attempt, and perception-action matching were calculated as dependent measures. Observed motor performance, age, gender and throwing experience were independent variables. Repeated measures ANOVAs indicated significant effect of distance on children's judgment and actual performance for both groups. Children with LP were more optimistic, but significantly less accurate than HP children. As distance continuously changed as control parameter the children showed change in their judgment and behavioural patterns. However, mid distances seemed to serve as critical points leading to transition in perception and action patterns, but in a different fashion for LP and HP groups. Multiple regressions indicated that experience appeared as a best predictor for throwing accuracy.

**Conclusion:** The results lead to conclude that their judgment was based on information about the relationship between relevant environmental properties and the properties of their own action system specifying judgment and behavioural category boundaries, but a judgmental task may be affected by other factors besides perception.

**Acknowledgments:** This work has been partially funded by Universidade Federal do Amazonas

## **Oxygen cost during incremental exercise in children with DCD and controls**

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**Background:** Children with DCD often have lower aerobic fitness compared to their peers and are likely to experience earlier fatigue than well coordinated individuals when engaging in physical activity. It has been suggested that this may be a consequence of compromised mechanical efficiency. The oxygen cost of work performed has been used as a proxy measure of mechanical efficiency. Examining oxygen cost will further our understanding of the differences between cardiorespiratory fitness in children with and without DCD.

**Aim:** The study objective was to compare the oxygen cost of children with DCD to that of healthy controls during a continuous, incremental exercise protocol to exhaustion.

**Methods:** This case-control study involved 63 subjects with probable DCD and 63 healthy controls (52 females and 74 males, 12-13 years of age), matched for age, gender, and school location. Subjects were assessed for motor proficiency using the Movement Assessment Battery for Children, 2nd Edition. Peak aerobic fitness (VO<sub>2</sub> peak) was measured by a progressive exercise test on a cycle ergometer. Mixed effects modeling was used to examine the main effects of DCD on oxygen cost at submaximal workloads, adjusting for relevant covariates.

**Results:** Children with DCD had significantly lower VO<sub>2</sub> peak values relative to controls (mean [SD]: 35.0 [7.66] vs. 42.9 [8.06] ml/kg/min,  $p < 0.0001$ ). Mixed effects modelling demonstrated that, after controlling for relevant covariates (body fat, peak VO<sub>2</sub>), children with DCD had a consistently greater oxygen cost compared to controls at any given submaximal intensity ( $p < 0.001$ ).

**Conclusion:** The results of this study indicate that children with DCD may need to utilize more oxygen to sustain the same level of submaximal workload relative to healthy controls. This difference in the mechanical efficiency of movement for children with DCD may be an important factor in submaximal performance and should be considered when interpreting cardiorespiratory fitness results in these children.

## Left ventricular structure and function in children with and without DCD

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**Background:** Children with developmental coordination disorder (DCD) are more likely to develop cardiovascular disease risk factors such as obesity and reduced cardio-respiratory fitness. These risk factors are associated with abnormal alterations in left ventricular structure and function in children and adolescents. However, there is limited data assessing cardiovascular health in children with DCD using laboratory measures.

**Aim:** The purpose of this study was to examine the differences in left ventricular structure and function in children with and without DCD. **Method:** The study involved 126 children (aged 12-13 years) with significant motor impairment (n=63) and healthy controls (n=63) matched for age, sex, and school. The Movement ABC test (M-ABC2) was used to classify children as probable DCD (p-DCD). Cardiac dimensions were measured using ultrasound echocardiography. **Results:** There was no significant difference in left ventricular mass (LVM) in the p-DCD group ( $89 \pm 17$ g) compared to controls ( $87 \pm 21$ g). However, the p-DCD group demonstrated significantly elevated stroke volume ( $p=0.03$ ), cardiac output ( $p<0.001$ ), end-diastolic volume ( $p=0.02$ ), and left ventricle diameter in diastole ( $p=0.02$ ). Also, peak VO<sub>2</sub> normalized for fat free mass (FFM) was significantly lower ( $p=0.001$ ) and systolic blood pressure ( $p=0.01$ ), body mass index ( $p=0.001$ ), heart rate ( $p=0.005$ ) and percent body fat ( $p<0.001$ ) were significantly higher in p-DCD. In regression analyses, p-DCD was a significant predictor of stroke volume and cardiac output after controlling for height, FFM, VO<sub>2</sub>FFM, and sex.

**Discussion:** Children with p-DCD demonstrate significantly elevated end-diastolic volume, diastolic chamber size, stroke volume, and cardiac output. These alterations may represent the early stages of developing left ventricle hypertrophy. Additional analyses on one and two year follow-up data is currently being assessed and will be added to the present study. This will help to determine whether these alterations persist over time and whether they develop into elevated LVM or hypertrophy.

## Temporal stability of visually induced postural stability for DCD

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**Background:** Developmental coordination disorder (DCD) influences many types of movement. Few studies have examined the role of optic flow in postural control among children with DCD.

**Aims:** We investigated postural responses to optic flow for children with and without DCD.

**Method:** A total of twenty children, eleven with DCD ( $< 5$ th percentile in M-ABC test) and nine matched controls, in the age of 10-11 years (mean age =  $10.7 \pm 0.5$  yr) participated in this study. Six conditions were created by combining frequency (0.1, 0.2, 0.3 Hz) and amplitude (1 or 2 cm) of oscillation of a moving room. Anterior-posterior of center of pressure (COPap) during 60 seconds was recorded to evaluate the postural sway induced by visible motion of the room. Data were converted to the frequency domain using fast Fourier transform (FFT). The dependent variables were relative phase between body and room, SD phase, coherence, gain of body relative to room motion, positional variability of COP, mean position of COP, and mean maximum spectrum.

**Results:** We found significant interaction between group and frequency in COPap. Also found significant interaction between group, frequency and amplitude in Maximum spectrum. There was a significant main effect for frequency. The greater perception- action coupling of body sway and visual stimulus at lower frequencies of room oscillation -- higher maximum spectrum and lower relative phase difference between room and postural sway. For the TD group, the amplitude COPap was higher at

slow frequency and decreased systematically at higher room motion frequencies, but the DCD group did not.

**Conclusion:** The results revealed that standing sway of both children with and without DCD were influenced by room motion. However, children with DCD responded differently than children without DCD. We concluded that DCD could influence a child's use of imposed optic flow for the perception and control of stance and that these effects are task-specific.

Key words: perceptual motor coordination, motor control and analysis

## Diffusion tensor imaging of children with DCD: a pilot study

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**Background:** Neuroimaging studies of children with developmental coordination disorder (DCD) are key to better understanding the neurobiology of this disorder. Recent publications have shown differences in patterns of brain activation in children with DCD compared to typically-developing (TD) children, but none have examined the integrity of motor pathways in these children.

**Aims:** The aim of this pilot study was to compare diffusion tensor parameters of the corticospinal tract, posterior limb of the internal capsule (PLIC), and superior cerebellar peduncle in children with and without DCD.

**Methods:** Seven children with confirmed or probable DCD and nine TD children participated (ages 8-12 years). We used diffusion tensor tractography to measure apparent diffusion coefficient (magnitude of water diffusion) and fractional anisotropy (direction of water diffusion) of the corticospinal tract; we used a region-of-interest-based approach to measure the same values in the PLIC and superior cerebellar peduncle.

**Results:** There were no between-group differences in fractional anisotropy values in any of the brain regions or in apparent diffusion coefficient values of the PLIC or cerebellar peduncles; however, even with adjusting for age, children with DCD had significantly lower apparent diffusion coefficient values in the corticospinal tract compared to TD children ( $F = 5.50$ ,  $p = 0.03$ ). Apparent diffusion coefficient of the corticospinal tract was also moderately correlated with scores on the Movement Assessment Battery for Children-2 ( $r = 0.56$ ,  $p = 0.01$ ).

**Conclusions:** In our small sample, children with DCD have similar fractional anisotropy values in motor pathways compared to TD children, suggesting that the microstructural integrity of these pathways are intact in DCD. Lower apparent diffusion coefficient in the corticospinal tract of children with DCD, and the correlation with motor scores, suggest that lower diffusivity may play a role in the presentation of DCD. These results should be replicated in a larger study to confirm these findings.

## Age-related differences in motor inhibition of symmetrical movements in children with DCD during a switching task

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**Background:** In typical child development, symmetrical bimanual movements stabilize rapidly whereas asymmetrical ones develop more progressively. Children with DCD experience more difficulties in producing stable bimanual coordination, especially when both hands move asymmetrically. Such difficulties in executing simultaneous conflicting motor commands could be associated to a reduced motor inhibition of symmetrical movements.

**Aims:** It follows that (1) children with DCD should demonstrate higher difficulties in switching from bimanual in-phase to unimanual movements (In-Uni) - requiring stopping one hand tapping while maintaining the ongoing tapping of the other hand - and (2) such impairments should decrease with age. Moreover, (3) greater stability of the in-phase tapping could predict better switching.

**Method:** To test these hypotheses, two groups of children (12 DCD and 12 control) of two age groups (7-8 and 9-10 years old) produce the In-Uni switching task following an auditory metronome (fixed tempo = 600ms). Data analyses focus on (1) the stability of the in-phase tapping, (2) the switching perturbation, assessed by the variability of the tempo at the moment of switching and (3) the correlation between these two variables.

**Results:** The results show that the in-phase stability significantly improves with age in the two groups, even though it remains globally more stable in the control group. At the moment of switching, the stability of the tempo is perturbed in both groups but this perturbation decreases with age, to an even greater extent in the DCD group. Moreover, higher in-phase stability correlates with lower switching perturbation, but in the control group only.

**Conclusion:** This study suggests that the difficulties in producing efficient inter-manual coordination in children with DCD could be associated to a reduced motor inhibition of symmetrical movements. In addition, it seems that DCD corresponds to a transient developmental delay of the capacity to overcome symmetrical movements rather than a purely motor deficiency.

## Visual tracking behaviour and movement kinematics during catching in children with DCD

Sathiskumar NianaSekaran<sup>1</sup>, Marius Ndiaye<sup>1</sup>, Siobhan Reid<sup>1</sup>, Brendan Lay<sup>1</sup>, Aaron Chin<sup>1</sup>, Jacqueline Alderson<sup>1</sup>, Melissa Licari<sup>1</sup>

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**Purpose:** To extend the current understanding of catching deficits in the DCD population, the present study examined visual tracking behavior and movement kinematics.

**Method:** Twenty-six male children participated, 13 with DCD (age = 9.36 years  $\pm$  0.68, MABC-2 = 2.25 $\pm$  2.02) and 13 controls (age = 9.16 years  $\pm$  0.68, MABC-2 = 52.31 $\pm$  23.02). A ball machine delivered a 15cm foam ball over 5m with flight characteristics standardized to deliver the ball at chest height. Participants performed 10 two-handed central catching trials, with the best 5 trials selected for analysis. Visual gaze behavior was determined using the Mobile Eye tracker capturing at 30Hz. Movement kinematics were determined using a 12-camera Vicon MX system capturing at 200Hz with participants wearing 54 retro-reflective markers placed on the head, trunk and upper limbs.

**Results:** Significant differences in visual behaviour were seen in the number of visual fixation locations prior to ball release ( $p=0.043$ ) and time to smooth pursuit at ball release ( $p=0.003$ ), with the DCD group fixating on more locations and delayed in time to smooth pursuit. Despite these initial differences in gaze behavior, there was no significant difference in time to initiate movement ( $p=0.144$ ). Analysis of kinematic differences from ball release to initial contact revealed that the DCD group displayed increased shoulder flexion, thorax extension, elbow extension, and greater variability in joint rotation. Sequencing of segments between groups occurred in the same order (elbow flexion, wrist extension, shoulder flexion), however the DCD group initiated wrist extension considerably earlier ( $p<0.05$ ). In regards to upper limb symmetry, joint angle correlations (determined using the coefficient of multiple determination, CMD) demonstrated significant asymmetries in elbow flexion-extension ( $p=0.01$ ) in the DCD group.

**Conclusion:** The findings of the present study demonstrate that errors made in positioning and timing, particularly at the elbow, were key contributors to poor catching performance.

# Saturday 25 June, oral presentations

## Auditoire César-Roux

### Improving fitness and motor skills in adolescents with DCD: Preliminary results from the AMPitup program

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**Background:** Adolescents with DCD need developmentally appropriate exercise programs that are meaningful and enjoyable, and also enable them to develop the skills, fitness and confidence to participate in community exercise settings as adults.

**Aims:** The aim of this study was to examine the effect of an exercise program on a range of physical fitness tests.

**Setting:** The Adolescent Movement Program (AMPitup) is offered in a university exercise clinic which contains modifiable cardio-exercise and strength training machines and a hydrotherapy pool. The program runs for 13 weeks in parallel with each University semester. Participants engage in a strength, fitness and skills program twice per week for 90 minutes.

**Method:** The McCarron Assessment of Neuromuscular Development was used to recruit 21 adolescents with low motor competence into the study over two semesters (Mean NDI =  $62.7 \pm 14.1$ ). Ten adolescents started in the first semester and were joined by another 11 in the second semester (13 males and 8 females ( $M = 168.2 \pm 21.6$  mths)). A battery of fitness assessments measuring aerobic fitness, muscle endurance, muscle strength, body composition and flexibility and parent questionnaires were completed pre and post each semester intervention.

**Results:** Fitness results for each test occasion were investigated using linear mixed models adjusted for age, sex, and number of sessions. While there was a mean shift for all tests, significant improvements between test occasions were only observed for the Multi-stage Fitness Test (MSFT), Curl-ups and Trunk lift. Examination of individual profiles revealed that some youth made more improvement than others particularly for tests closely related to their exercise program. Most parents (96%) reported observable increases in the confidence and fitness of their child.

**Conclusion:** Individually-designed programs based on modifiable cardio-exercise and strength training equipment are effective in building fitness in adolescents with DCD. When training is closely aligned to the fitness test, improvements are greater. Other implications will be discussed.

### Motor intervention as a strategy to improve motor deficits among school children with ADHD

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**Background:** ADHD and DCD are considered overlapping conditions. ADHD is associated with motor problems such as fine motor control, balancing and object control skills, although these problems of ADHD children do not receive much attention from an intervention perspective. Strategies that are used to improve symptoms related to ADHD are mediation, neuro-motor feedback, behaviour modification, and sensory-motor intervention.

**Aims:** To determine if different intervention methods for ADHD will improve the motor development of

children with ADHD.

**Method:** Seventy three (N=73) primary school children diagnosed with ADHD with a mean age of 6.98 years (SD = 0.65) were randomly divided into different treatment groups, namely motor intervention, Sharper Brain (neuro-feedback), medication (Ritalin) and a ADHD-control group. A group of typical children without ADHD was selected as a second control group. The motor intervention and Sharper Brain groups did not receive any medication and followed 12 week-specific intervention programmes. All groups were tested and retested by means of the MABC measuring instrument. Data were analysed by means of variance of analysis (ANOVA) and post hoc analyses of between group differences ( $p < 0.05$ ).

**Results:** The results showed that the MABC total and fine motor control of the motor intervention group decreased, although not significant ( $p > 0.05$ ), while the other groups stayed the same or showed poorer results after the intervention.

**Conclusion:** It can be concluded that motor problems of ADHD children will not be rectified by medication or cognitive approaches, but that specific motor intervention programs can address the motor shortcomings of these children.

Key words: intervention, motor control, diagnoses, assessment, ADHD, MABC

## Clinical change following a 13 week intervention program for children with DCD

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**Background and Aims:** Ninety-three children meeting the criteria for a diagnosis of DCD participated in an intervention program within the health and education sectors in South Australia. Previous literature reviews and meta-analyses concluded that intervention for DCD provides better outcomes than no intervention, however no gold standard of intervention has been identified. The following results aim to look at the main trends of change at a clinically significant level following intervention and consider cases which did not follow the trends.

**Methods:** Participants were assessed at three time intervals (pre-intervention, post-intervention, 6 months post-intervention) using the Movement Assessment Battery for Children (MABC) following 13 weeks of group intervention. The intervention was based on a mixture of intervention theories with a bias to task-specific training. Treatment sessions were themed (eg. going to the beach) to give extra context to tasks completed during intervention.

**Results:** MABC scores improved significantly over time. At pre-intervention assessment, 55 participants were in the definite impairment category (5th percentile cut-off) and 38 in the borderline impairment category (15th percentile cut-off) on MABC scoring. Following intervention 27 remained in the definite impairment category, 28 were in the borderline impairment category and 37 participants scored within normal limits ( $> 15$ th percentile) with one participant lost to follow-up. At six months post-intervention 29 participants were in the definite impairment category, 20 participants were in borderline impairment category and 42 participants within normal range. Statistical analysis confirmed significant improvement over time  $p < 0.01$ .

**Conclusion:** Overall 45 percent of participants had scores within the normal range following intervention and of the 60 percent of participants who started in the definite impairment category half of these improved to move to another category. An explanation of these results will be postulated and cases which did not show improvement, will be discussed with the assistance of secondary measures to help explain results.



## Persisting motor and handwriting difficulties in children with ADHD following pharmacologic treatment

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**Background:** Children with Attention Deficit Hyperactivity Disorder (ADHD) are at risk of exhibiting motor and handwriting difficulties, negatively impacting self-perception, academic performance and other meaningful occupations. Approximately 50% of the ADHD population meets the criteria for Developmental Coordination Disorder (DCD). The extent of these motor difficulties and their responsiveness to pharmacologic interventions remains unclear.

**Aims:** To determine whether children with ADHD with motor and handwriting difficulties improve following treatment on stimulant medication. Factors associated with persisting motor difficulties will also be explored.

**Methods:** This study is describing motor and handwriting capacity in children newly diagnosed with ADHD, prior to and following daily use of stimulant medications. Children between 6-10 years were assessed by a blinded occupational therapist using standardized measures of motor skills, to include the Movement Assessment Battery for Children (MABC) and the Developmental Test of Visual Motor Integration (VMI), as well as handwriting capacity using the Evaluation Tool of Children's Handwriting. Testing was performed before initiation of a long-acting stimulant medication and three months after.

**Results:** To date, 43 children (35 males, 8.2±1.2 years) completed all phases of this prospective study. At baseline, motor impairments were highly prevalent (72.1%) with manual dexterity most likely to be suboptimal. Handwriting performance exhibited high variability in terms of speed and legibility. Consistently, age, results on the VMI and on the MABC ball skills domain were predictors of letter and word legibility both at baseline and after intervention. Word and letter legibility and all MABC subscales significantly improved ( $p < 0.05$ ) after pharmacologic intervention. However motor impairments were still persistent in 53.5% of the sample.

**Conclusion:** In children newly diagnosed with ADHD, use of stimulant medication was associated with significant improvements in motor and handwriting skills. However, an important subset demonstrates persisting motor and handwriting difficulties and still requires interventions to minimize the functional impact of DCD as a common comorbidity.

## Graphomotor disorders in children with autism spectrum disorders: Due to impaired motor functioning?

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<sup>1</sup>Ghent University, Ghent, Belgium

**Background:** It is well established that children with Developmental Coordination Disorder (DCD) often have poor handwriting. However, dysgraphia is not restricted to DCD alone. Children with Autism Spectrum Disorders (ASD) also show an overall worse handwriting compared to typically developing children (TD). It was suggested this was due to deficient motor skills.

**Aims:** This study explored if graphomotor problems in children with ASD are primarily linked to poor motor functioning.

**Methods:** Participants 32 children with DCD, 21 high-functioning children with ASD (HFA), 28 children with HFA combined with additional movement problems (HFA+DCD) and 41 TD children between 7 and 12 years old participated. Diagnosis of ASD was made based on a previous clinical assessment according to the DSM-IV criteria. DCD was diagnosed if children 1. scored  $\leq 5^{\text{th}}$  percentile on the M-ABC-II and 2. were referred by centres of remedial education and rehabilitation or by private

physiotherapists and 3. were receiving physiotherapy.

Instruments 'Systematische Opsporing van Schrijfmotorische stoornissen' (SOS-test) evaluates both handwriting quality and speed.

**Results:** A significant difference in handwriting quality was found between the four groups ( $H(3)=44.39$ ;  $p\leq.001$ ). Children with DCD ( $p\leq.001$ ), HFA ( $p\leq.001$ ) and HFA+DCD ( $p\leq.001$ ) had a poorer handwriting quality compared to TD children. Furthermore, children with HFA+DCD wrote less legible than children with HFA ( $p=.03$ ). However, both autism groups did not differ significantly from children with DCD.

The four groups differed significantly in handwriting speed ( $H(3)=17.92$ ;  $p\leq.001$ ). Children with DCD ( $p\leq.001$ ), HFA ( $p=.003$ ) and HFA+DCD ( $p=.003$ ) wrote fewer letters in 5 minutes than TD children. No significant difference was found between the three clinical groups.

**Conclusions:** Even when no movement problems are present, children with ASD have handwriting abilities similar to those of children with DCD. In ASD, other functions beyond motor skills seem to have a significant impact both on handwriting quality and on speed.

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## Saturday 25 June, oral presentations

*Auditoire Auguste-Tissot*

### Developing a care pathway for children with DCD

Christine Owen<sup>1</sup>, Kirsty Forsyth<sup>1</sup>, Donald Maciver<sup>1</sup>, Jacqueline Whitehead<sup>1</sup>, Mike Walsh<sup>2</sup>, Mandy Mulvanny<sup>3</sup>

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**Introduction:** A key method of managing DCD is through the assessment and interventions of allied health professionals (AHPs) e.g. physiotherapists, occupational therapists. In this presentation we describe the development and implementation of an AHP care pathway focusing on the child's journey from referral through to intervention, discharge and self management. The development of care pathways for children with DCD is a departure from the norm, providing a unique opportunity to improve services and outcomes for children and families.

**Method:** NHS QIS\*, Queen Margaret University, Stirling University and NHS Lothian commenced on a process to review current service pathways in light of published standards for children with DCD (NHS QIS 2007\*\*). This research included a review of current evidence (NHS QIS 2007\*\*), workshops with professionals, in-depth interviews with parents and professionals, culminating in the development of a new care pathway. The project was facilitated by an academic and practice partnership of experts in child and family research, health professionals and management scientists. The new pathway has been implemented and evaluated at a demonstration site in the United Kingdom, where a facilitated change process was used to support both health and education staff to use the pathway.

**Results:** Our pathway has been developed in collaboration with parents, AHPs, medical staff, teachers, and academics to support the engagement of parents and children throughout their care journey. We have developed a number of protocols, including collaborative goal setting, timely diagnosis and participatory intervention.

**Conclusions:** The integration of multiple perspectives is important to ensure an evidence based approach to developing contemporary services for children with DCD. Our work will allow AHP services to provide consistent approaches to the support and management of DCD.

## Building clinical expertise in DCD through a community of practice

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**Background:** Communities of Practice (CoP) are an effective strategy for translation of knowledge into practice. One CoP for pediatric occupational and physical therapists, established to share information on Developmental Coordination Disorder (DCD), naturally evolved over several years to include all four elements of the Health Care Decision-Making (HCDM) Model (Dobson, 2010).

**Aims:** To describe the evolution of a CoP on Understanding DCD and the breath of its learning sessions, which influenced therapeutic intervention strategies and addressed issues related to quality of life of children with DCD and their families.

**Method:** Twenty CoP sessions over 2 years fell naturally into the HCDM Model: (1) study of research evidence (conference findings, reports of intervention workshops, review of synthesis of the literature, psychometric properties of common assessments); (2) discussion of health care resources (delivery models within regional health, school, private and community services, community resources for DCD, management implications of referrals for DCD); (3) consideration of patient/family preferences (inclusion of parents in CoP, parent and child panel discussion, case studies, successful intervention strategies); and (4) clinical circumstances affecting the child (discussion with speech therapists, role of vision and optometry, impact of fatigue and motivation).

**Results:** Broad areas of discussion which evolved resulted in change within clinical knowledge and practice.

**Conclusions:** When pediatric therapists had the opportunity to share information within a supportive environment through participation in CoPs, clinical expertise was fostered. With skilled facilitation and membership input into topics, many aspects of practice which contribute to clinical decision making were addressed.

## Multidisciplinary implementation of task oriented approaches for children with DCD: national Dutch example of change management in professional reality

Jolien van den Houten

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**Background:** The transition of process-oriented approaches towards task-oriented approaches in the intervention of children with Developmental Coordination Disorder (DCD) is high on the agenda of researchers, Occupational, Physical and Speech Therapists worldwide. Within the Netherlands this transition is managed with political support of paediatric rehabilitation centres. The process is structured by the Dutch DCD Steering Group, existing of researchers in the field of DCD. The Dutch Steering Group has been organising a line of national policy conferences that founded the transition process and enables national working groups initiating change in professional reasoning and decision-making.

**Aim:** The Dutch Multiprofessional DCD working group of Occupational, Physical and Speech therapists is a Community of Practice that launched a national transition process in professional reasoning and decision-making, underlining the European Guidelines process and the Leeds Consensus Statement.

**Method:** The Dutch Multiprofessional DCD working group consist of 25 representatives of paediatric rehabilitation centres, outpatient clinics and community practices and implements task oriented approaches and change in professional reasoning and decision-making in a theoretical based, systematic and structured way. Major activities from the Process of Change Framework (Neufeld, 1995) are followed. Another theoretical foundation forms the concept of Communities of Practice (Simons, Germans et al. 2003). These theoretical foundations offer a Framework in which structured learning

activities are organised. Homework takes care of a follow up in the own practice.

**Results:** Effective groupwork has brought the Dutch Multiprofessional DCD working group: ? Focus on the child with DCD and significant others (Ferlie, 2001) ? Active multiprofessional learning and teamwork (Barr 2005; Reid, Bruce et al. 2006) ? Within a (learning) network of leading figures (Grol et al, 2005) ? Change in professional reasoning and decision-making in the interventions of Children with DCD (Wilson, 2005) ? Implementation of task-oriented interventions (Polatajko & Mandich; Smits-Engelsman; Sugden)

The (inter) national interest in this transition process and outcome is growing. The followed procedure towards more effective treatment for children with DCD offers inspiration and suggestions to others interested in professional innovations in the work environment.

The author is chair of the Dutch DCD Steering Group, chair of the Dutch Multiprofessional DCD Working Group. 'Implementation of task-oriented interventions (Polatajko & Mandich; Smits-Engelsman; Sugden). The (inter) national interest in this transition process and outcome is growing. The followed procedure towards more effective treatment for children with DCD offers inspiration and suggestions to others interested in professional innovations in the work environment.

## **Family-focused tele-intervention for children with DCD: development and lessons learned**

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**Background:** Despite the high frequency of developmental coordination disorder, sufficient remedial treatment has not yet been provided in medical or educational systems. Instead of relying on costly unavailable specialists, families can be at the centre of intervention. Family focused intervention for DCD not only empowers the family, but also enables children with DCD to receive an effective frequency of individualised intervention three times or more per week, which is difficult to attain in clinical and school settings due to the cost and time involved in treatment and transportation.

**Aims:** To develop a family-focused tele-intervention program for children with DCD and to evaluate the program.

**Method:** Eleven children with DCD (7-10 years of age, 1 female, 10 males) and their families participated in this study. The case formulation approach and Bronfenbrenner's Theory of Ecological Development formed the theoretical base for the program content. This pilot work involved the development of prototype materials (Phase 1), trialing and process evaluation with 3 children and their families (Phase 2), refinement of the program, and a further trial with two other groups of 4 children and their families (Phases 3-4).

**Results:** We developed a workbook, 3 DVDs, telephone support, and a blog to teach children at home. After the intervention, 3 of 7 children had progressed beyond the cutoff for DCD on the Movement Assessment Battery for Children, Second Edition. Although the Developmental Coordination Disorder Questionnaire failed to demonstrate any participants progressing beyond the cutoff for DCD, all families reported improvement in their children's functional motor skills, such as tying shoelaces, riding a bicycle without training wheels, and sports skills.

**Conclusion:** Family focused tele-intervention has a potential role to play in supplementing the exiting educational, medical and community resources. However, more work is needed to resolve some outstanding issues regarding assessment, diagnosis, telephone consultation, Internet support systems.

## The relationship between DCD, child's perceived self-efficacy and preference to participate in leisure activities

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**Background:** Studies highlight that the motor difficulties experienced by children with Developmental Coordination Disorder (DCD) may negatively impact their self-efficacy and contribute to their withdrawal from participating in activities. These studies referred mostly to physical activities. The relationship between children's self-efficacy and participation patterns in additional activity types should be elucidated.

**Aims:** This study aimed to compare self-efficacy and preference to participate in various leisure activities of children with DCD and typical peers and to illuminate the relationship between self-efficacy and activity preference among children with DCD. In line with the client-centered principles this study used child's self reports.

**Methods:** 37 children with DCD and 37 typical peers aged five to nine years performed the Movement Assessment Battery for Children (MABC), the Perceived Efficacy and Goal Setting System (PEGS), and the Preference for Activities of Children (PAC).

**Results:** Children with DCD had significantly lower self-efficacy in all PEGS scales: Self-care ( $F=12.244^{***}$ ), School/Productivity ( $F=10.762^{**}$ ) and Leisure ( $F=29.296^{***}$ ) and lower preference to participate in activities as: physical ( $F=21.077^{***}$ ), social ( $F=6.877^*$ ) and skilled based activities ( $F=.351^{**}$ ). Their lower self-efficacy was correlated with lower motor performance ( $r=-.337$ ,  $p=.041$ ) and lower preference to participate in various activities.

**Conclusions:** Children's preference to participate in activities may be impacted by their motor abilities, and further hindered by low self-efficacy. Early identification of DCD and associated negative outcomes may enable early intervention and minimize the negative effects of DCD. The evaluation and intervention process should use the valuable input based on child's self-reports. This process may lead to better therapy results, enhance child's development and participation, and elevate emotional and physical well-being.

# Saturday 25 June, workshops

## Auditoire César-Roux

### Motor skills, working memory, and academic achievement in a normal population of adolescents: a test of a mediating model

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**Background:** Although research supporting the relationship between motor skills and academic achievement has accumulated, the nature of this relationship remains unclear. Recent findings however, have suggested an important link between motor skills, working memory, and learning outcomes in children with DCD (Alloway, 2007). Such research has significant implications from both a theoretical and practical perspective and therefore, requires further attention.

**Aims:** The aim of the current study was to examine a mediating model of the relationship between motor skills, working memory, and academic achievement in a normal population of adolescents. A partially mediating model was proposed.

**Method:** Ninety-three adolescents aged 12 to 16 years were assessed using the Movement Assessment Battery for Children-2 (MABC-2), Wechsler Individual Achievement Test-II (WIAT-II), Wechsler Intelligence Scale for Children-IV (WISC-IV), N-back paradigm, and the Strengths and Weaknesses of ADHD and Normal Behavior (SWAN).

**Results:** The direct and indirect effects of motor skills and working memory on academic achievement were estimated through a structural equation modeling approach. The results revealed that after controlling for WISC-IV verbal comprehension index, ADHD symptoms and SES, the path coefficient from motor skills (specifically, MABC-2 'aiming and catching' as 'manual dexterity' and 'balance' did not meet the premises to mediation) to academic achievement was not significant therefore, a direct effect of motor skills on academic achievement was not supported. However, the path coefficient from motor skills to working memory was positive and statistically significant, working memory was found to have a direct positive effect on academic achievement, and motor skills were found to have an indirect effect on academic achievement through working memory.

**Conclusion:** Overall, the results of this study revealed that the direct path between motor skills (i.e., aiming and catching) and academic achievement did not make a significant contribution to the model rather, the mechanism whereby motor skills is related to academic achievement can be best understood through its indirect effect through working memory. These findings may have important implications for early prevention, assessment, and intervention of motor skill and learning difficulties.

## Auditoire Tissot

### Évaluation écosystémique des besoins des enfants ayant un TAC au primaire pour favoriser leur participation sociale et leur accomplissement de soi

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**Problématique :** À ce jour, peu d'études ont défini, de manière systématique, les besoins des enfants ayant un TAC et de leur famille. En plus, il n'existe pas d'étude de besoins pour les enfants ayant un TAC au Québec. Or, l'étude de besoins est une étape recommandée pour la planification et

l'élaboration des services.

**Cadres de référence** : Cette démarche d'évaluation des besoins s'appuie sur le modèle écosystémique de Bronfenbrenner, mais également le modèle du Processus de Production du Handicap et la théorie de la motivation de Maslow.

**Objectif** : Cette étude identifiera et priorisera d'un point de vue écosystémique les besoins des enfants ayant un TAC, en lien avec leur participation sociale et leur accomplissement de soi.

**Méthodologie** : Pour opérationnaliser cet objectif, une étude de cas multiples et des méthodes de recherche mixtes seront utilisées. Huit enfants ayant un TAC, âgés entre 6 et 12 ans, seront recrutés, de même qu'un de leurs parents et leur enseignant principal. La collecte de données inclura une analyse documentaire des dossiers de l'enfant, des questionnaires ainsi que des entrevues semi-dirigées.

**Retombées anticipées** : Ce projet vise à contribuer à l'amélioration des services pour les enfants ayant un TAC, en vue d'optimiser leur participation sociale et leur accomplissement de soi.

### ***Salle Andros, PMU***

## **Les difficultés de l'enfant dyspraxique à la maison et à l'école et les aides applicables dans leur vie quotidienne**

Corinne Masson-Friedli  
*Association Dyspra quoi, Suisse*

Cet atelier est plus particulièrement destiné aux parents d'enfants dyspraxiques ou atteints d'un Trouble de l'acquisition de la coordination motrice. Il décrira les difficultés que ces enfants rencontrent dans la vie quotidienne et à l'école. Des situations concrètes seront abordées, les déficits seront explicités et quelques aides proposées.

### ***Auditoire Yersin***

## **Wirklich eine UEMF? Differentialdiagnose der motorischen Funktion**

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**Hintergrund:** Die Diagnose UEMF ist eine Ausschlussdiagnose (Kriterium III). Spezifische neurologische Ursachen und ein genereller Entwicklungsrückstand sollen ausgeschlossen und Komorbiditäten erwogen werden.

**Inhalt:** Der vorliegende Workshop soll anhand von Videobeispielen mögliche Differentialdiagnosen erwägen. Eine Checkliste wird vorgestellt. Zeit für allfällige eigene Beispiele nach Voranmeldung möglich.

## Salle séminaire 2

### Classroom public speaking on DCD; peers experience hands-on the meaning of poor motor performance

Annelies de Hoop<sup>1</sup>, Jolien vandenHouten<sup>2</sup>,

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**Background:** In the classroom situation children with DCD experience not only difficulties with scholastic tasks such as handwriting; they are also confronted with the psychological and social effects resulting from their poor motor performance. The 'invisible' cause of their problems leads to misunderstanding and negative remarks from their teachers as well as classroom peers. The relationship between motor performance with social isolation, rejection of peers and poor self-esteem needs attention from all who work with children with DCD (Taylor, 1984).

**Method:** Public speaking is practiced once or twice a year in all grades of Dutch schools. REC Midden-Brabant-Mytelschool Tilburg sees this as an opportunity to help children with DCD to give peers more insight in how poor motor performance affects their daily life. They offer a so-called 'DCD obstacle course' in which the classroom peers experience all kind of tasks confronting them with motor performance problems; 'this is what it feels like for me'. The teacher is offered an interactive role during the course (Sugden, 2003).

**Aim:** Overall enabling children with DCD to share their perception of the impact of DCD on daily activities, in order to improve the understanding of peers and social interaction at school. The aim of this workshop is to let the participants experience the 'DCD obstacle course' and offer more detailed theoretical background information.

**Results:** By experiencing these performance difficulties classroom peers gain insight and understanding on the effects of their behaviour towards the child with DCD (Poulsen, 2008). The child with DCD reflects actively on how his motor performance affects daily activities and learns how to verbalize his experiences while developing psychological awareness and social interacting skills (Watson, 2006).

## Salle séminaire 3

### What about handwriting? Evidence-Based Statement (EBS) as guidance for decision-making for children with handwriting problems

Anneloes Overvelde<sup>1,2,3</sup>, Ingrid van Bommel-Rutgers<sup>2,4</sup>, Ida Bosga-Stork<sup>5,6</sup>, Mathieu van Cauteren<sup>7</sup>, Bert Halfwerk<sup>6,8</sup>, Bouwien Smits-Engelsman<sup>2,9</sup>, Ria Nijhuis-van der Sanden<sup>10</sup>

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**Purpose:** To achieve evidence based algorithm for assessment and intervention for children with handwriting difficulties.

**Relevance:** Many children (10-34 %) encounter serious problems in acquiring the complex skill of handwriting. Between 25-50 % of all intervention sessions in pediatric physical therapy in the Netherlands is dedicated to children with handwriting difficulties.

**Methods:** As a first step an inventory was made concerning questions in the practical field. Next a systematic review was performed and after selection, based on the content of the abstracts, fulltext



articles were scored on relevance and methodological quality. Based on the evidence levels of the literature, for each question conclusions on etiology and recommendations on assessment, and intervention were formulated. A multidisciplinary group of experts was consulted to discuss the recommendations and the usefulness for daily practice. After that the Hypothesis Oriented Clinicians Algorithm was used to describe clinical reasoning and decision-making and the process was depicted in a flowchart (see poster). Five possible profiles of handwriting difficulties are described and linked to the intervention.

**Conclusions:** This EBS contributes to the understanding of underlying perceptual motor processes and co-occurring problems of this clinical group. It will guide decision-making in clinical practice and improve the transparency for other people involved in helping these children (primarily teachers and parents). Physiotherapists and occupational therapists can use these recommendations to facilitate their specific role in the management of children with handwriting difficulties. Moreover, the literature review pointed out that there is a lack of high quality comparative intervention studies.

**Implications:** The Dutch EBS, as guide for clinical reasoning and evidence based practice, will contribute to adequate referral and treatment of children with dysgraphia caused by underlying motor learning or coordination disorders.

## **Salle Séminaire 4**

### **Highlighting activity and participation in the evaluation process of children with DCD**

Batya Engel-Yeger<sup>1</sup>, Sara Rosenblum<sup>1</sup>, Naomi Josman<sup>1</sup>,

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**Background:** DCD negative consequences on child's functioning and well-being emphasize the need to refer to DCD according to ICF model emphasizing the interaction between body functions, activity and participation. Yet, a debate exists regarding the optimal evaluation process, the suitable measures included in different evaluation stages, and the optimal outcomes interpretation.

**Aims:** to enable participants to:

1. Broaden their knowledge about DCD deficits manifested in brain research.
2. Be exposed to the interaction between deficits related to DCD and child's activity and participation.
3. Be introduced to an evaluation model focused on activity and participation.
4. Be introduced to the Do-Eat ? a new developed performance-based measure assess child's daily activities.
5. Be aware to optimal use of existing measures in regard to child's strengths and weaknesses.
6. Have the opportunity to dialogue with colleagues about DCD issues concerned with evaluation and treatment.

**Methods and Results:** Systematic literature review about brain mechanisms, DCD deficits and their impacts on child's activity and participation will be presented. The evaluation model and its rational will be explored. Psychometric properties of the "Do-Eat" and results concerning activity and participation of children with DCD will be elaborated. Suggestions for using additional measures in the evaluation process will be provided. Following that, an interactive discussion based on the audience's experience, will take place.

**Conclusions:** The suggested workshop will be one step towards practical application of the ICF model for children with DCD and will highlight its importance for enhancing child's development, functioning and well being.

**Salle Paros, PMU**

## **Demystifying misconceptions about case study research with an example of balance assessment**

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**Background:** Experimental findings on the specificity and transfer of learning may not be relevant to practitioners because of the difference between the experiment conditions and intervention situations. This case study examines the theoretical issue by conducting balance training with real-life tasks and evaluating the teaching outcomes through teaching observation and on the performance of balance tests.

**Aims:** To describe how case formulation and intervention for common balance problems in children are conducted, and to explore the reasons why observed learning outcomes of balance training may be or may not be reflected on the performance of balance test items.

**Method:** Two children who met the diagnostic criteria of developmental coordination disorder participated in this study. They were individually taught by student teachers at a teaching and research laboratory for 17 weeks over a 28-week period. We used a mix-method multiple case study design with two cases to test the alternative hypotheses, specificity vs. transfer of learning by theoretical generalization, in which each case is tested against the hypotheses. The effects of balance training were assessed with the Movement Assessment Battery for Children (MABC) (Henderson & Sugden, 1992) and through teaching observation of functional balance skill development. The analytical method of pattern matching was used to examine the match between the improvement patterns shown by balance test tasks and real-life balance tasks.

**Results:** Training resulted in an improvement of the balance skills that corresponded with the sets of tasks and environments employed for the specific balance training in one case. The other case improved performance not only on the trained balance tasks, but also on the performance test balance tasks in the MABC.

**Conclusion:** Transfer and specificity of learning can be explained by the similarities between teaching tasks and test items, the directions of transfers, and the possible contributions of non-balance factors.

**Salle Samos, PMU**

## **The development of an intervention program based on both the evidence and what families want!**

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This workshop aims to go through the practical aspects of developing an intervention program that meets the requirements of the evidence and which is accessible to families. It will be based around the 13 week group intervention program run in South Australia as an RCT from 2006 to 2008 for 93 children with DCD.

This workshop will include sample programs which can be used in practice, as well as practical information gained from families to assist in running accessible programs. The content of the discussed program will be compared to that of three other intervention studies which have used different intervention parameters or underpinning theories. It will provide an opportunity for delegates to discuss some of their intervention strategies in the light of current evidence. The program to be discussed was

developed for an RCT comparing different personnel and environments of intervention for children with DCD. The MABC, TGMD-2, Pictorial Scale of Self Competence and Social Acceptance for Young Children, School Function Assessment and Parental and Child Questionnaires were completed pre/post and 6 months post intervention. A cost effectiveness analysis was also completed.

The MABC was the primary outcome measure and found all intervention groups to show a significant improvement over time  $p < 0.01$  with nearly 50 percent of participants moving to within normal range on the MABC. There was found to be no significant difference between running the intervention in a school or health environment based on MABC findings but some practical considerations may inform us otherwise. There was also no significant difference between school assistants and physiotherapists running programs based on MABC results  $p > 0.05$ . Parental information provided a different view of results with regard to personnel and environment.

## *Auditoire Jéquier Doge*

### **Ghent Developmental Balance Test**

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**Background:** Various developmental motor disorders cause poor balance, resulting in difficulties with different functional tasks involved in activities of daily living. Several standardized developmental tools are available for motor skill assessment. Most of these tests encompass multiple balance tasks. Some of them offer a specific balance subscore. However, a sensitive tool to systematically monitor balance in the young age-group was lacking.

**Aim:** To develop a new assessment tool to evaluate balance from the moment of independent walking to 5 years of age.

**Method:** Starting from a review of the different balance items from the Peabody Developmental Motor Scales-2 (Folio & Fewell, 2000), the Körper Koordinationstest für Kinder (Kiphard & Schilling, 1974), the Movement Assessment Battery for Children (first and second edition) (Henderson & Sugden, 1992, 2007) and the Bruininks Oseretsky Test for Motor Proficiency-2 (Bruininks & Bruininks, 2004) and after obtaining clinicians opinion a developmental series of 35 balance items for children between 18 months and 5 years 11 months was constructed. A pilot study was set up to check the series. A test manual was drawn up to objectify the assessment procedure. To evaluate test-retest reliability 70 children were assessed twice by the same tester with an interval of one week. The association between age and test result was investigated.

**Results:** Test-retest reliability was very good with an ICC of 0.99 and a SEM of 6.25. At item level ICC varied between 0.61 and 0.99. The Pearson correlation coefficient between test score and age of the children was 0.94.

**Conclusion:** Preliminary the Ghent Developmental Balance Test seems to be a reliable tool for the evaluation of balance in young children from the moment of independent walking to the age of 5 years 11 months.