Developmental Coordination Disorder
Not just a movement problem

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Poor Motor Coordination: A Disability

- **Childhood Motor Deficiency Syndrome** (Dupre, 1911)
  - awkwardness of voluntary actions
  - excessive tendon reflexes
  - mild hypertonicity

- **The Clumsy Child** (Orton, 1937)
  - both gross and fine motor difficulties
Terms Used to Describe Movement Difficulties
(adapted from Henderson & Barnett, 1998, p. 211)

- Clumsy
- Apraxia
- Dyspraxia-Dysgnosia
- Physically Awkward
- Poorly Coordinated
- Perceptual-Motor Dysfunction

- Delayed Motor Development
- Children with Movement Difficulties
- Minimal Brain Damage
- Minor Neurological Dysfunction
- Motor Infantilism
Developmental Coordination Disorder
(DCD: APA, 1987)

A. Poor **motor performance** in relation to chronological age.

B. Significantly interferes with **academic achievement** or **activities of daily living**.

C. Not associated with a general medical condition (e.g., CP) and does not meet criteria for a Pervasive Developmental Disorder.

D. If Mental Retardation is present, motor difficulties are **greater** than expected.
What types of movement problems?

- Poor fine motor control (e.g., writing)
- Poor gross motor control (e.g., running)
- Speech which lacks fluency
- Abnormal muscle tone (hypo/hyper tonia)
- Poor body awareness (kinaesthesia)
- Difficulties with gross motor sequencing (developmental dyspraxia)
Is this a common problem?

• **Prevalence**
  – Reported estimates of between 5 and 19% of primary school aged children.
  – Estimates suggest 1 in 10 children in Australia have motor coordination difficulties

• **Gender differences**
  – findings inconclusive but some suggestion of higher prevalence in boys
Problem 1
How do we identify DCD in children?
Identifying DCD?

• **Performance tests of motor ability:**
  – Bruininks-Oseretsky Test of Motor Proficiency (BOT - Bruininks, 1978)
  – Movement Assessment Battery for Children (MABC – Henderson & Sugden, 1992)
  – McCarron Assessment of Neuromotor Development (MAND – McCarron, 1997)

• **Screening tools**
  – MABC teacher/parent checklist
  – DCDQ (Wilson et al., 2000)
MABC Teacher Checklist

- In a sample of 171 children aged between 9 and 12 years, 32 children were identified with DCD (Piek & Edwards, 1997)
- Class teachers identified 25% of these using the MABC checklist (50% of the severe cases).
- Physical education teachers identified 47%, but only 36% of the severe cases.
Why a problem with identification?

- Opportunity to observe the children in a variety of environments and contexts is an important variable.
- Not being aware of DCD as a developmental disorder.
- Confusion with other problems  
  - e.g., inattention, learning difficulties.
Do we need to identify this disorder?

Problem 2:
What impact does DCD have on children?
Low competence and self-worth

Harter, 1987
Self-Perceptions and Self Worth in 8-10 year old children

Self Perception Profile for Children

Mean scores for each domain of the SPP

<table>
<thead>
<tr>
<th>Domain</th>
<th>DCD</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>scholastic</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>social</td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>athletic</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>physical</td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>behavioral</td>
<td></td>
<td></td>
</tr>
<tr>
<td>self-worth</td>
<td>*</td>
<td></td>
</tr>
</tbody>
</table>

Skinner & Piek, 2001
Self-Perceptions and Self Worth in 12-14 year old adolescents

Mean scores on each domain of the Self Perception Profile for Adolescents (SPPA)

Skinner & Piek, 2001
Self-worth and Social Support

Competence/Importance Discrepancy

SELF WORTH

Social Support/ Positive Regard

Affect

Motivation

Harter, 1987
Perceived Social Support

Children

<table>
<thead>
<tr>
<th>Type of Support</th>
<th>Approval</th>
<th>Emotional</th>
<th>Instrumental</th>
</tr>
</thead>
<tbody>
<tr>
<td>DCD</td>
<td>3.1</td>
<td>3.3</td>
<td>3.5</td>
</tr>
<tr>
<td>Control</td>
<td>3.05</td>
<td>3.25</td>
<td>3.4</td>
</tr>
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</table>

Adolescents

<table>
<thead>
<tr>
<th>Type of Support</th>
<th>Approval</th>
<th>Emotional</th>
<th>Instrumental</th>
</tr>
</thead>
<tbody>
<tr>
<td>DCD</td>
<td>3.2</td>
<td>3.4</td>
<td>3.6</td>
</tr>
<tr>
<td>Control</td>
<td>3.15</td>
<td>3.35</td>
<td>3.55</td>
</tr>
</tbody>
</table>
Self-worth and Affect

Harter, 1987
Anxiety in Children and Adolescents with DCD

Skinner & Piek, 2001
Promoting Self-Esteem through Physical Activity

Such intervention programs aim to:

“encourage school-aged children to develop self-esteem and positive mental health through sport and activity” (Prue Drever, InPsych, 2002)
Self-perpetuating cycle of perceived lack of competence.

- Perceived lack of competence
- Limited opportunity to practice and develop skills
- Non-Participation

Harter, 1978
Early Intervention

• Fundamental Movement Skills Program (Dept of Education, 2001)

• Pilot study on 40 kindergarten children between 3.5 and 5.5 years – 20 intervention and 20 control.

• Examined
  – Movement (MAND)
  – Anxiety (CBCL)
  – Self-perceptions (Harters Pictorial Scale)
  – Emotional recognition (ERS)
Preliminary Results

• No significant difference between groups for any of the measures

• However, there is an indication that children who are poor on motor ability are improving (in relation to controls) on:
  – movement
  – anxiety
Behaviour Checklist at Age 8

Clinical Problems

Means

- Aggressive Behaviour
- Attention Problems
- Delinquent Behaviour
- Other Problems
- Social Problems
- Somatic Complaints
- Thought Problems
- Withdrawn Behavior
- Anxiety/Depression

DCD
Control

* Indicates significant difference.
What is the link between DCD and other Disorders?

Gillberg’s (1992) DAMP MODEL

- Deficits in
- Attention
- Motor control - gross and fine motor skills
- Perception (Gillberg, 1992)
Gillberg’s DAMP Model

- DAMP (MPDAD(H)D): 4.2% to 7.1%
- AD(H)D: 7%
- MPD: 4%
- Asperger syndrome: 0.3%
- Developmental coordination disorder/clumsy child syndrome: 0.3%
- Severe DAMP (MPDAD(H)D): 1.2%
- Hyperkinetic disorder: 7%
- Autistic features: 0.7%
DCD and comorbidity

- Gillberg (1992)
  - DCD and ADHD (and Autism?)
- Bonnie Kaplan and colleagues (1998)
  - DCD, ADHD and Learning disorders
- Piek and colleagues (1999, 2003)
  - DCD and all 3 ADHD subtypes
- Hill (2001)
  - DCD and language impairment.
Problem 3
Are the difficulties found in children with DCD due to other comorbid developmental disorders?
Is Poor Motor Ability a Result of Inattention in ADHD children?

- Link between inattentive symptomatology and motor ability, in particular fine motor ability (McGee et al., 1985; Piek, Pitcher & Hay, 1999).

- DSM-IV suggests that the motor skill problems of children with ADHD are "usually due to distractibility and impulsiveness, rather than to motor impairment"
Purdue Peg Board
# ADHD and fine motor ability

<table>
<thead>
<tr>
<th>GROUP</th>
<th>PPB score (no. of pins)</th>
<th>INATTENT</th>
<th>HYP/IMP</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONTROL</td>
<td>37.66 (4.13)</td>
<td>3.61 (2.47)</td>
<td>2.29 (2.27)</td>
</tr>
<tr>
<td>ADHD</td>
<td>36.88 (5.09)</td>
<td>19.63 (5.27)</td>
<td>15.55 (7.69)</td>
</tr>
<tr>
<td>ADHD + DCD</td>
<td>32.50* (4.99)</td>
<td>18.78 (4.95)</td>
<td>13.95 (6.76)</td>
</tr>
</tbody>
</table>

(Pitcher, Piek & Hay, 2003)
Are there common mechanisms?

**Mechanisms identified in DCD**
- Deficits in perceptual processing
  - kinaesthetic ability
  - cross-modal integration
  - visual-spatial organisation.
- Deficits in timing mechanisms.

**Mechanisms identified in ADHD**
- Executive Functioning
  - Response inhibition (particularly ADHD-C)
  - Working memory (particularly ADHD-PI)
Deficits in Visuo-Spatial Organisation in ADHD?

Compared children with and without ADHD and/or DCD

- Control (n = 37)
- ADHD (n = 49)
- [DCD (n = 8)]
- ADHD + DCD (n = 55)
WISC-III: Performance IQ

Performance IQ can be divided into:

**Perceptual Organisation**
- Picture completion
- Picture arrangement
- Block design
- Object assembly

**Processing Speed**
- Coding
- Symbol search
Results

- **Verbal IQ** – Vocabulary and Similarities
  - (Control = ADHD = DCD) > ADHD/DCD

- **Processing Speed** – Coding & Symbol Search
  - Control > ADHD > ADHD/DCD

- **Perceptual (Visuo-spatial) Organisation** - BD, OA, PC, PA
  - Control = ADHD
  - Control > (DCD = DCD/ADHD)
Timing deficits in children with DCD

Problematic timing functions have been identified in sequential tapping tasks (e.g., Lundy-Ekman, Ivry, Keele, & Woollacott, 1991; Missiuna, 1994; Williams, Woollacott, & Ivry, 1992).

The neural localisation of a central timing deficit has been hypothesised to be within the cerebellum (Williams et al., 1992), with some evidence that the basal ganglia may influence variability in force production (Lundy-Ekman et al., 1991).
Reaction Time and DCD

(Piek & Skinner, 1999)
ADHD and Reaction Time

Pitcher, Piek & Barrett, 2002
Executive function and ADHD

**Executive functions** - the complex cognitive processes required to perform novel or difficult goal-directed tasks
- the ability to delay or inhibit a particular response
- develop a plan of action sequences
- hold a mental representation of the task through working memory

**Children with ADHD** - consistently score lower on measures of:
- motor inhibition and
- working memory (Pennington & Ozonoff, 1996).
Executive Functioning and DCD

- 76 control and 28 children with DCD
- Three measures of EF
  - Goal neglect task – goal-directed planning
  - Go/No go task – response inhibition
  - Trailmaking/ memory updating – working memory

Piek et al., 2004
Executive Functioning and DCD

- DCD group poorer on RT task
- No evidence of problems with:
  - go/no-go task (response inhibition)
or
  - goal neglect task (goal directed planning).
- A weak but significant effect for the trailmaking/memory task (working memory)
  - but only for the timing measure.
Five Developmental Disorders

• INTELLIGENCE:
  – Intellectual Disability (ID)

• COMMUNICATION:
  – Language Disorder (MLD)

• MOTOR:
  – Developmental Coordination Disorder (DCD)

• ATTENTIONAL:
  – Attention Deficit Hyperactivity Disorder (ADHD)

• EMOTIONAL:
  – Autism (A)
Developmental disorders - Profiles

**IQ**: ID < [AUT=MLD=DCD]<[DCD=I=C]

**LA**: ID < [AUT=MLD]<[C=I=DCD]

**EA**: ID < [AUT=MLD=DCD]<[DCD=I=C]

**MA**: ID < AUT < DCD < [C=MLD=I]
Summary of profiles in relation to DCD

- **Intellectual Disability**
  - Poorer on all 4 abilities compared with other disorders
  - No strengths in ability

- **Autistic Disorder**
  - Can be distinguished from DCD by MA and LA

- **Mixed Language Disorder**:
  - Can be distinguished from DCD by LA and MA

- **ADHD-C and ADHD-PI** have similar profiles:
  - Can be distinguished from DCD by MA (EA and IQ?)
ADHD/DCD Comparison

MC
IQ
LA
EA

DCD
ADHD-C
ADHD-I
DCD and Empathic Ability

Empathic Ability: ERS (Dyck, Ferguson, & Shochet, 2001).

- **Emotion Recognition Scales:**
  - Fluid Emotions Test
  - ‘Accuracy’ & ‘Speed Given Accuracy’
  - Vocal Cues Test

- **Emotion Understanding Scales:**
  - Emotion Vocabulary Test
  - Comprehension Test
  - Unexpected Outcomes Test
Is DCD an ‘empathy disorder’ as suggested by Gillberg?

- Empathic ability relies on several basic processes, including the ability to accurately perceive visual cues within interpersonal contexts.
- Can poor visuo-spatial ability in children with DCD account for their poorer empathic ability?
Results

We compared 39 children with DCD, with 39 children matched on age (6-13 years) and gender:

• We found that children with DCD perform more poorly on scales that measure the ability to recognise static and changing facial expressions of emotion (Cummins, Piek & Dyck, 2005).

• These can partially explain the poor social functioning of children with DCD.

Cummins et al., 2005
Summary

• Problem 1: Identification of DCD
  – Several reliable performance tests are now available
  – Still requires considerable work to find reliable and valid screening tools
  – Parents, health professionals and teachers need to be aware of the disorder
Summary

• **Problem 2: Impact of DCD on the child**
  – Lower self-perceptions (including academic achievement)
  – Lower perceptions of social support
  – Lower self-worth
  – Higher levels of anxiety and depression
  – Withdrawn
  – Attentional problems
Summary

• **Problem 3: Comorbidity**
  – Linked with other disorders such as ADHD, language and learning disorders.
  – Research indicates that children with DCD have distinct problems, such as poor perceptual organisation and poor timing control, that are not associated with these comorbid conditions.
  – Mechanisms such as poor visual-spatial organisation can be linked to poor empathic ability, and hence their poorer social skills.
Conclusion

• Few interventions have been successful to date.

• However, awareness of DCD and the problems associated with it will allow parents, teachers and health professionals to develop strategies that will aid in the healthy physical and mental development of these children.