Physical Activity, Social Participation and Fitness in Children with Developmental Coordination Disorder/Dyspraxia

First Annual Conference
Research Institute of Health and Medical Professions
Ono Academic College
June 10, 2007

Sharon A. Cermak, Ed.D., OTR/L, FAOTA
Professor of Occupational Therapy
Boston University, Dept. Occupational Therapy
cermak@bu.edu
International Health Concerns: Increased Childhood Obesity, Decreased Physical Activity

- There has been a significant increase in obesity and risk-for-obesity among children and adolescents over the last few decades, esp. among affluent countries.

- Health epidemic in US
  - Increasing rates of childhood obesity (NHANES)
    - 31% of children 6-19 are overweight or at-risk for overweight
    - 250% increase among adolescents from 1970 to 2002
  - Associated decrease in physical activity and increase in sedentary activity
    - Children spend an average of 3 to 4 hours a day watching TV
      - Inactive children are more likely to become inactive adults
    - Proportion of children attending PE classes in schools has decreased from 41% in 1991 to 29% in 1999 (Grunbaum et al., 2002 cited in Cole et al., 2006)

- Of particular concern because obesity is associated with major health risks
  - Hypertension, cardiovascular, Type II diabetes
Similar trends in many nations, including Israel

- Bar Dayan et al. (2005) examined records of >76,000 17-year-old Israeli conscripts
  - Low prevalence of obesity – 4%
  - “Alarmingly high” prevalence of borderline overweight
    - 12.4% males, 11.4% females
  - Increased prevalence of hypertension and Type II diabetes in individuals with BMI>30
Cross-sectional data from >13,000 second- and fifth grade school children

From 1990 to 2000, BMI values increased, and the proportion of obese children at 95th percentile increased in all age and gender categories using both Israeli and US reference values

- ↑ 12.7% and 11.8% for 2nd grade boys and girls, respectively
- ↑ 10.2% and 8.4% for 5th grade boys and girls

Authors concluded, “This substantial increase in childhood obesity poses a serious health threat, and requires implementation of suitable public health interventions”
Physical Education Classes in Israeli Middle School Children

Direct observation of level of PA during PE classes in 20 non-obese children

- In 45-minute class,
  - 18.4 minutes moderate-vigorous activity (M>F)
  - 6.2 minutes in vigorous activity (M>F)
- Authors conclude that PE class may not achieve recommended levels of PA

Harefuah, 2007 Apr, 146(4), 265-8
Various factors may account for obesity

- Changes in diet
  - Increased fast food
- Changes in life style
  - Increased sedentary activity
  - Decreased physical activity
- Child factors
  - Coordination
DCD → Motor Coordination & Skill → ↓ Participation → ↓ Physical Activity → ↑ Sedentary Behavior → ↑ Risk for Obesity → ↓ Fitness → DCD

Cermak & Larkin, 2002
Focus of Presentation

- Developmental Coordination Disorder/Dyspraxia- What is it? So what?
  - Impact on Daily Living and School Performance
- Social Participation in Children with DCD
- Physical Activity and Fitness in Children with DCD
- Self-efficacy in Children with DCD
- NIH-funded research study to examine relation of child motor coordination with physical activity, fitness (including risk for obesity) and self efficacy
- Long term goals and Approaches to intervention

A. Performance in daily activities requiring motor coordination is markedly below the expected level, given the person’s chronological age and intellectual capacity.

This may be manifested by marked delays in achieving motor milestones (walking, crawling, sitting), dropping things, “clumsiness”, poor performance in sports, or poor handwriting.
DCD criteria cont.

B. The disturbance in (A) significantly interferes with academic achievement or activities of daily living

C. Not due to a known medical condition such as cerebral palsy, hemiplegia, or muscular dystrophy and does not meet criteria for Pervasive Developmental Disorder

D. If Mental Retardation is present, the motor difficulties are in excess of those usually associated with it
Incidence/Prevalence

- 5 to 13% of the school-aged population
- 3M : 1F
Terminology across time and discipline

- Clumsy child
  (Gubbay, 1975)

- DCD
  (DSM III, 1987+)

- Dyspraxia
  (Ayres, 1965)
  (Sanger et al., 2006)
Relationship of Dyspraxia, Clumsiness and DCD
The Clinical Picture of DCD

CHARACTERISTICS
Clumsy
Slow Learning Activities of Daily Living
Feeding
Dressing
Personal Grooming
Gross Motor Skills and Sports
COORDINATION AND COMMUNICATION... THOSE ARE YOUR PROBLEMS, CHUCK!

YOUR MIND TELLS YOUR BODY TO DO SOMETHING, YOUR BODY DOESN'T OBEY... YOUR MIND AND YOUR BODY HAVE TO WORK TOGETHER!

MY MIND AND MY BODY HATE EACH OTHER!
Problems in Constructive Manipulatory Play and Poor Fine Motor Skills
Poor Handwriting
(dysgraphia)

Matthew, age 9 (entering fourth grade)
108 seconds
Co-Morbidity with DCD

Learning Disability
Attention-Deficit/Hyperactivity Disorder
DAMP (Deficit in Attention, Motor Control, and Perception) Sweden
Dyslexia- Automatization Deficit Hypothesis (cerebellum)
They always pick me last. This morning they were all fighting over which team had to have me. One guy was shouting about it. He said it wasn’t fair because his team had me twice last week. Another kid said they would only take me if his team could be spotted four runs. Later, on the busy, they were all making fun of me, calling me a “fag” and a “spaz”. There are a few good kids who aren’t mean, but they don’t want to play with me. I guess it could hurt their reputation.”
Friendships and Isolation

- Children with DCD reported they had fewer playmates and were less often asked to play with other children (Shoemaker & Kalverboer, 1994).
On the School Playground

- Smyth & Anderson (2000) observed playground activity of 100 children, ages 6-10, half w DCD and half with typical coordination

- Children w DCD
  - Were more onlookers and more isolated on playground
  - Wandered aimlessly more often
  - Were in large groups of children less often
  - Took part in team games (e.g. football) less often if boys
  - Took part in large informal team games less often if girls

- Children in DCD group were variable in amount of time spent in different forms of playground activity
More on School Playground

- Primeau (1992) observed children on school playground
  - Children w DCD participated 27% of time compared with 84% for typical children
In a qualitative interview of 12 parents of 8 children with DCD, parents believed their children’s motor impairments restricted participation in society (Mandich et al., 2003)

Susan’s Mom: “She has come home from school in tears a couple of times because she couldn’t play tag games at school on the playground. And you know that while that’s not a life threatening thing that to me is a quality of life issue”
Further Understanding Participation

- Parents reported that successful participation built confidence in their children and allowed them to try other new activities (Mandich et al. 2003)
Participation Using Self-Report Questionnaire

- Participation Questionnaire (Hay, 1992): 61-item one-year recall
- In 929 children from grades 4-8, children with DCD (n=44) reported less participation in both organized and free play activities (Cairney, et al., 2005)
Smyth & Anderson (2001) looked at the relation of time spent in team sports (football) during free time in school. They looked at children from their 2000 study who had scored poorly on MABC. As a group, children with DCD spent more time alone but some children engaged in sports despite poor coordination. Amount of time in football related in part to balance (postural control), not ball skills on MABC. Children with extremely poor balance did not participate. Participation may relate to self-esteem, motivation.
Social Participation

- Competence in sports is an important factor contributing to a child’s social status (Weingarten, 1980).
- Kangioglou et al. (2005) conducted a sociogram study (peer nomination method) with 154 5th and 6th graders with a range of coordination abilities.
  - Children with moderate-severe coordination problems (MABC) had lower scores on social acceptance and higher social rejection than children without coordination difficulties.
Reduced PA is a major problem for all children
Barriers to Physical Activity

- Community Factors
  - Opportunities not available
  - Opportunities too costly
  - No transportation
  - Neighborhood not safe

- Family Factors
  - Busy parents... unable to arrange or transport
Barriers continued

■ Social Factors
  ■ Adults who run activities do not make child feel welcome
  ■ Adults who run activities do not have skill to include child successfully
  ■ Children participating in activities reject child and do not allow him/her to participate

■ Child Factors
  ■ Child has difficulty with social or learning skills that make participation difficult
  ■ Child has poor coordination that make participation difficult
Assessing Physical Activity

Many self or parent report questionnaires

- Previous Day Physical Activity Recall (PDPAR) 24 hour recall - Trost et al., 1999
- Participation Questionnaire- Hay, 1992

Objective Measures

- Observation
- Accelerometry
Observing PA in Children with DCD

- Bouffard et al. (1996) Children w DCD spend less time in physically active pursuits
- Bouffard et al. (1999) observed children during school recess
  - Children with motor difficulties were vigorously active less often, played less often with large playground equipment
- Larkin & Parker (1999)- playing computer games was more common in children with DCD (more sedentary)
Physical Activity

- In study of children in Holland (Visser et al., 1998), children and parents completed questionnaire. Asked to retrospectively estimate # hrs/wk they spent and how much time each day they spent in
  - Physical Exercise including sports and physical education at school
  - Fine motor activities including hobby work such as model making, and art/craft classes at school

- Children w DCD spent 58% less time on activities in physical exercise; no differences between groups on FM activities
Objective Measures of PA Using Accelerometry
Consequences of Reduced PA: Activity Deficit Hypothesis

- Poor motor performance and physical fitness may be the result of a lack of sustained effort and practice, which leads to decreased self perceptions of competence and further lowering of rates of participation in physical activities (Bouffard et al., 1996)
FITNESS in Children with DCD
Two Types of Fitness

Health Related Fitness

- Cardiorespiratory endurance
- Muscular strength and endurance
- Flexibility
- Body composition (Body Mass Index)- Obesity

-Usually associated with health promotion and disease prevention

Skill Related Fitness

- Agility
- Speed
- Power

-Important for the acquisition of motor skills

Both types of fitness relate to general health and well-being in children

In typical children, cardiorespiratory endurance improves with age.

In children w DCD, performance was no longer improving by age 8+.

May be explained by fact that cardiorespiratory endurance is maintained through regular participation in PA, and this decreases w age in children w DCD (Hay et al.)
DCD and Health Risk

Theoretical Model proposed by Faught et al. 2005
Muscular Strength and Endurance in Children with DCD

- Reduced muscular strength and power (Raynor, 2001)
  - Children w DCD have lower levels of peak torque during isometric and isokinetic knee flexion and extension tasks

- Abdominal strength and endurance lower in children with DCD on a 60-second sit-up test (O’Beirne et al., 1989)
  - Mean was 15th percentile
Fatigue and DCD

- Inefficient movement patterns and mechanical inefficiency can involve high energy demands.
- As a consequence, children with DCD can fatigue much earlier than individuals with better coordination (O’Beirne et al., 1994; Hands & Larkin, 2002).
- Fatigue reduces ability to enjoy and participate enthusiastically in many daily activities and may contribute to reduced participation at home, in school, and on the playground.
Flexibility

- Def - range of motion through which joints are able to move
- Markedly varies in children with DCD and varies from joint to joint (Hands & Larkin, 2002)
- Bimodal distribution - hypo and hyperflexibility
  - This can contribute to injury and long term musculoskeletal problems
BMI-Obesity and DCD

- Common tests of body fat include BMI (a ratio of height to weight) or skin-fold thickness measured with calipers.
- Most studies done looking at BMI in children with DCD have been done outside US and found higher BMI:
  - **Australia** O’Beirne et al., (1994) 7-9 yo boys with DCD have higher BMI; Hands & Larkin (2002)- 8/52 children w DCD had BMI > 20 : 3/50 in control group
    - Raynor- no diffs in younger children but older DCD heavier than peers
  - **Holland** Visser et al. (1998) followed children w DCD from ages 11-14. Children w DCD consistently heavier than controls (same height)
  - **Canada** Faught et al. (2005)- DCD associated with increased body fat
- Additional weight may increase movement difficulties.
  - Significant energy cost
BMI- Chart Review
OTA-Watertown Data Base

- 38 children, ages 6-11, met criteria for DCD and had height and weight measures
- 26.3% at risk for overweight (BMI > 85\textsuperscript{th} percentile for age and gender)
- 13.2% overweight (BMI > 95\textsuperscript{th} percentile for age and gender)
- Comparison to NHANES 1999-2002
Skill-Related Fitness

- By nature of their disorder, children with DCD have impaired motor skill
  - Agility (ability to change direction or body position quickly)
    - Agility run- mean percentile rank of 8 (O’Beirne & Larkin, 1991)
    - Agility run- 71% of children with DCD scored below 10th percentile (Larkin & Hoare, 1991)
  - Speed (ability to perform movement as quickly as possible; function of strength, coordination, and agility)
    - 50 meter sprint- reduced speed (O’Beirne, Cable, & Larkin, 1994)
  - Power (combination of strength and speed)
    - Eg. Sprint, standing broad jump
    - Anaerobic cycling reduced levels of power and 50-m run (O’Beirne, Cable, & Larkin, 1994)
Fitness Summary

- Children develop fitness through PA
- Because movement is so hard for children w DCD, they are less likely to be physically active
- Low PA is a risk factor for low fitness and related obesity
- Thus, children w DCD are at risk for low levels of physical fitness
- Low fitness contributes to low participation and decreased enjoyment of PA
- This further contributes to low levels of fitness
PERCEIVED SELF-EFFICACY

- Def: An individual’s judgment (confidence) in their own capabilities to achieve a *specific* goal/ learning outcome in a *specific* situation
  - Compare to self-worth (self-esteem)
- Based on work of Bandura
- The beliefs that individuals have about themselves has a powerful effect on their behavior
  - Self-fulfilling prophecy
Children with poor motor coordination perceive themselves as less physically competent than their teammates (Henderson, May, & Umney, 1989; van Rossum & Vermeer, 1990; Rose, Larkin & Berger, 1997; Piek, Dworkan, Barrett, & Coleman, 2000; Skinner & Piek, 2001)

Low self-perceptions not limited to motor competence

- Children with poor motor competence also perceived themselves as less physically attractive, fewer friends, lower in academic competence, social acceptance (summarized in Piek et al., 2006)
Self-Concept/ Self-Efficacy

- Children with poor coordination disorders show lower self-concept
  - developmental double jeopardy

(Losse et al., 1991; Piek et al., 2000; Shaw, Levine, & Belfer, 1982)

- Children with DCD have greater anxiety, lower self-worth, and perceive themselves as less competent (Skinner & Piek, 2001)
Piek et al., 2006 examined relation between type of motor impairment and self-efficacy

- Children w DCD were poorer than controls in both fine and gross motor skills
- Children and adolescents with fine-motor motor problems perceive themselves as being less competent in scholastic achievement
- Children and adolescents with gross-motor problems perceive themselves as being less competent in athletic competence
Self-Efficacy Relates to Participation

Cairney et al. (2005) found that

- Children with DCD had lower self-efficacy than children with typical coordination
- Children with lower self-efficacy were less likely to participate in PA
- Therefore when planning intervention, need to target self-efficacy (psychosocial interventions to improve coping and quality of life)
Our Research Study

- Funded by NIH/ NICHD
- Designed to examine relation of motor coordination in children and physical activity, participation, fitness and perceived self-efficacy
- Second related NIH-funded study in children with Autism, looking at relation of diet, sensory issues, physical activity and obesity
Research Team

Principal Investigator
- Sharon A. Cermak, Ed.D., OTR/L - Occupational Therapy

Co-Investigators
- Linda Bandini, Ph.D.- Nutrition
- James Gleason, MS, P.T. - Physical Therapy
- Carol Curtin, MSW- Social Work
- Aviva Must, Ph.D. and Sarah Anderson, Ph.D.- Epidemiology/statistician

Represents collaboration among five disciplines and three Universities: Boston University, University of Massachusetts Medical School, and Tufts University School of Medicine
Measures

- **Assessing Physical Activity and Participation**
  - Parent Questionnaires
  - Accelerometry (Actical)
  - Conner’s Parent Rating Scale

- **Assessing Fitness**
  - BMI
  - Strength subtest of BOT-2
  - Six-Minute Walk Test (6MWT)
    - Distance Walked
  - Heart Rate during 6MWT
  - Perceived Exertion (OMNI scale) during 6MWT

- **Assessing Perceived Self Efficacy**
  - Active Winners Scale
(Very) Preliminary Findings

- **Participants**
  - Ages 7-11
  - Average to above average intelligence
  - No ASD; no known neuromotor (e.g. CP, MD)
  - Learning disabilities, ADHD okay

- **Identification of DCD**
  - Movement Assessment Battery for Children (MABC) <15th percentile
  - Parent report of current and/or past functional difficulty (list of 24 items)
### Group Characteristics

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>DCD</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>25</td>
<td>12</td>
</tr>
<tr>
<td>Age</td>
<td>X (SD)</td>
<td>9.5 (1.4)</td>
</tr>
<tr>
<td>MABC*</td>
<td>X (SD)</td>
<td>3.2 (2.3)</td>
</tr>
</tbody>
</table>

*MABC- impairment score; higher score indicates greater impairment*
## Parent Rating of Child’s Coordination and Impact on Function

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>DCD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age child walked</td>
<td>X (SD)</td>
<td>11.8 (2.0)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>15.4 (2.4)</td>
</tr>
<tr>
<td>Gross motor skills*</td>
<td>X (SD)</td>
<td>2.0 (1.0)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.9 (0.9)</td>
</tr>
<tr>
<td>Fine motor skills*</td>
<td>X (SD)</td>
<td>2.4 (1.0)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.0 (0.9)</td>
</tr>
<tr>
<td>Functional difficulty-past (# items of 24)</td>
<td>X (SD)</td>
<td>1.4 (3.5)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8.3 (6.3)</td>
</tr>
<tr>
<td>Functional difficulty-present (# items of 24)</td>
<td>X (SD)</td>
<td>1.2 (3.1)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7.3 (6.0)</td>
</tr>
</tbody>
</table>

* Higher score indicates parent rated child as having poorer skill compared to others the same age
## Parent Ratings of Child’s Physical Activity

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>DCD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level of PA compared to others</td>
<td>X (SD) 3.6 (1.0)</td>
<td>2.7 (0.8)</td>
</tr>
<tr>
<td>Likes PA compared to others</td>
<td>X (SD) 3.9 (0.9)</td>
<td>2.5 (1.1)</td>
</tr>
<tr>
<td>Recreational time</td>
<td>X (SD) 3.2 (0.9)</td>
<td>2.3 (1.1)</td>
</tr>
<tr>
<td># Days exercise 20 min in last 7 days</td>
<td>X (SD) 4.0 (2.1)</td>
<td>2.8 (2.8)</td>
</tr>
<tr>
<td>Impt PA to respondent</td>
<td>X (SD) 1.5 (0.6)</td>
<td>1.6 (0.7)</td>
</tr>
<tr>
<td>Impt PA to spouse</td>
<td>X (SD) 2.2 (1.4)</td>
<td>2.2 (1.4)</td>
</tr>
</tbody>
</table>
# Fitness Assessments

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>DCD</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BMI</strong></td>
<td>X (SD)</td>
<td>18.7 (1.6)</td>
</tr>
<tr>
<td><strong>BOT-2 Strength</strong></td>
<td>X (SD)</td>
<td>17.4 (5.2)</td>
</tr>
<tr>
<td><strong>6MWT- distance walked (ft)</strong></td>
<td>X (SD)</td>
<td>1867 (210)</td>
</tr>
</tbody>
</table>
## Accelerometry: Level of Weekday Activity Based on Actical Cut-Offs

<table>
<thead>
<tr>
<th>Activity Level</th>
<th># min/day</th>
<th>Control</th>
<th>DCD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wearing Actical</td>
<td>X (SD)</td>
<td>778.6 (75.3)</td>
<td>779.4 (48.7)</td>
</tr>
<tr>
<td>Sedentary</td>
<td>X (SD)</td>
<td>334.2 (56.9)</td>
<td>330.9 (58.6)</td>
</tr>
<tr>
<td>Light</td>
<td>X (SD)</td>
<td>273.6 (39.3)</td>
<td>289.5 (39.9)</td>
</tr>
<tr>
<td>Moderate</td>
<td>X (SD)</td>
<td>167.9 (47.6)</td>
<td>156.3 (40.3)</td>
</tr>
<tr>
<td>Vigorous</td>
<td>X (SD)</td>
<td>3.0 (3.0)</td>
<td>2.7 (2.6)</td>
</tr>
</tbody>
</table>
Long-Term Goal of our Research

- Design focused interventions to promote health and wellness in children with difficulty in motor skills and other related developmental disabilities
INTERVENTION FOR CHILDREN WITH DCD

- Plan for a healthy, active lifestyle
- Educate children (and families) about the value and enjoyment of regular physical activity
- Help children to find some developmentally appropriate activities in which they will enjoy some success, such as walking, jogging, swimming, cycling, martial arts, etc
Healthy Lifestyle

- Cyclical - Intervention can occur at multiple levels. All interact.

- Improve Motor Skills
- Increase Physical Activity
- Improve Physical Fitness
- Enhance Self-Efficacy
- Increased Enjoyment

Note: Also must consider Nutrition
Enhancing Participation and Fitness by Improving Motor Skill

- Improved Motor Skill
- Increased Inclusion and Opportunities to Participate
- Increased Enjoyment
- Increased Physical Activity
- Increased Health and Fitness
- Enhanced Self-Efficacy
Learning Needed and Wanted Motor Skills is Important

Roger’s Dad (Mandich et al., 2003) “Learning to ride a bike has helped his socialization and self-esteem. Just the way it has made him feel good about himself because he was able to do that. He’s more adventurous in other aspects of it. I think having learned to ride the bike then he took ownership of it and moved on to trying other things.”
Increasing Physical Activity and Fitness
(must consider Nutrition as well)

- Improve Motor Skills
- Improve Physical Fitness
- Increased Enjoyment
- Increase Physical Activity
- Enhance Self-Efficacy

B
Attitudes and Opportunities in Schools and Home

- Teachers, coaches, and parental belief and value systems may support or constrain physical activity participation of children with DCD

- Opportunities to practice, interest in child’s activities by significant others, and quality of instruction are environmental factors that influence participation

- Physical environments which support physically active play in non-competitive situations can be advocated by therapists working in school environments
  - Reduce emphasis on competitive sports and increase resources directed towards health-related fitness

- Parental involvement in physical activity.
DCD, Self-Efficacy, and Participation in Physical Activities

Proposed Model by Cairney et al. 2005
Increase confidence and willingness to participate in physical tasks

- Pless et al. (2001). A 10-week intervention did not reduce actual motor impairments but did improve perceived self-efficacy toward specific tasks (e.g. tying shoelaces) in children with DCD
Improving Self-Esteem in Children with DCD Through OT

- Pilot study (McWilliams (2005))
- 6-8 week OT group for children with DCD
  - 1 x/week; focused on motor-based activities (e.g. hockey skills, balloon volleyball, obstacle courses)
- Used global measure of self-esteem
- Change in self-esteem score was n.s. but parents reported that children enjoyed being in peer group and felt it gave them confidence and increased willingness to try new things.
- Limitation: not self-efficacy; change in motor skills not assessed.
Future Directions

- Collaboration with colleagues in Israel

- Thank you!! Toda!!
Acknowledgments

- Occupational Therapy Associates and participating clinics
- Parents and children