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### Step-by-step: Examining foot targeting precision in children versus adults

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When walking within a complex environment, such as stone-stepping, individuals rely heavily on visual and somatosensory feedback to maintain their balance. Any deviation from an expected foot placement location results in adults sacrificing accuracy of foot placement to maintain balance control. It is unknown whether children, who produce highly variable actions during obstacle crossing, possess similar adaptive strategies as adults during stone stepping. Specifically, are children able to adjust their locomotor strategies to accurately step towards displaced foot targets, similar to adults? The current study had middle-aged children (8–12Y,  $n=10$ ) and young adults (18–25Y,  $n=10$ ) step on nine rectangular steppingstones, evenly dispersed ( $L=50\text{cm}$ ,  $W=10\text{cm}$  apart) along a 5m pathway. Once participants began walking, a virtual steppingstone, 3.5m along the pathway, was set to remain in the same location or displace 10cm anteriorly, posteriorly, medially, or laterally. Furthermore, the virtual steppingstone either remained visible throughout the trial or disappeared 200ms following the shift in location. Participants completed 20 trials of each visual condition in a counter-balanced, block randomized design. We hypothesized that children would have greater trunk variability and greater errors in foot placement when the virtual steppingstone disappeared compared to adults. As expected, children had greater trunk pitch variability ( $X=2.86$ ) during the stone stepping task compared to adults ( $X=1.77$ ;  $F(1,17)=7.95$ ,  $p=0.012$ ,  $f=0.47$ ). Accuracy of foot placement was influenced by the amount of visual information provided ( $F(1,17)=5.94$ ,  $p=0.027$ ,  $f=0.35$ ), with greater error in foot placement with lack of visual information, but was not influenced by age group ( $p>0.05$ ). The results from the current study suggest that middle-aged children use visual feedback in a similar manner as adults during a stone stepping task. Overall trunk control may not be fully developed by 8–12 years old, resulting in an increased risk of injury during complex tasks and/or environments. Funding source: National Sciences and Engineering Research Council of Canada

### A dynamic system's approach to understanding adaptive locomotion in individuals with developmental coordination disorder: A systematic review

Victoria Rapos, University of British Columbia; Griet Warlop, Ghent University; Jill Zwicker, University of British Columbia

Developmental coordination disorder (DCD) is common but under-recognized neurodevelopmental disorder that significantly affects a person's ability to learn motor skills and perform daily activities. Current literature suggests that DCD may be caused, in part, by problems in perception-action coupling, resulting in difficulties in adaptive locomotion. To date, adaptive locomotion literature has not been synthesized within a framework that may shed light on factors contributing to functional difficulties experienced by individuals with DCD, or strategies to improve their motor function. Using dynamic systems theory as a framework, our systematic review (PROSPERO ID: CRD42022383963) aims to understand how motor behavior during adaptive locomotion differs in individuals with DCD compared to similar-aged peers. We searched eight databases (PubMed, EMBASE, Medline, Web of Science, Scopus, CINAHL, Cochrane Library, PsycINFO) over a 20-year period (2002–2022). Following systematic screening by two independent reviewers, 29 articles were included for data extraction. Of the 29 studies, 4 studies examined adults, 23 studies examined children (5–17 years), and 2 studies included adults and children with DCD during adaptive locomotion. Eight studies

examined obstacle avoidance, circumvention, or crossing, 4 studies used a dual task walking paradigm, 3 manipulated visual information, 2 involved obstacle targeting, 2 assessed road crossing abilities, 1 manipulated somatosensory information, and 1 study looked at stair negotiation. Further data extraction regarding the individuals, tasks, and environments of each study was completed and study quality was assessed using the Appraisal tool for Cross-Sectional Studies (AXIS). This systematic review is the first to synthesize evidence of problems in perception-action coupling as highlighted by adaptive locomotor tasks in children and adults with DCD. Findings will inform targets for intervention to improve function and safety of individuals with DCD to successfully navigate obstacles in their surroundings. Funding source: Natural Sciences and Engineering Research Council of Canada

### Grip force improved following assisted cycle therapy (ACT) in children with Down syndrome

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Almost 60% of children with Down syndrome (DS) do not meet the recommended aerobic activity each week. In the past, exercise has been difficult for children with DS, however, assisted cycle therapy (ACT) is an innovative technology which is a stationary bicycle with a motor that moves the children's legs at a rate greater than they could produce on their own and for a longer time so they can achieve the benefits of exercise. Thus, the purpose of this study is to examine a 2x/week for 8 weeks 30 minute ACT intervention on fine motor control in children with DS. It was hypothesized that grip strength measured with a hand dynamometer and manual dexterity as measured by the Purdue Pegboard test would improve following an 8-week ACT intervention. Paired sample *t*-tests were conducted pre and post for each measure. The results showed significant improvements in grip force following ACT. One explanation for improvements from pre to post in fine motor control may be due to the fact that the prefrontal cortex has a role in global motor function and was activated during 8 weeks of ACT leading to cortical changes that were evident in improvements in fine motor control. Our results are discussed with respect to their future implications for the benefits of exercise for young children with DS.

### Relationship between motor competence, weight status, and cardio-respiratory fitness from 7 to 16 years of age

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Strong evidence has been found for a negative relationship between motor competence (MC) and weight status (WS), and a positive one between MC and health related fitness (HRF). Nevertheless, most of the instruments used for determining MC do not include information about the three major components (stability, locomotor, and manipulative), or their specific relationship to WS or HRF. Using the motor competence assessment (MCA), that entails the three components of MC and specifically designed to assess MC throughout the life span, we aim to disentangle some of these questions from 7 to 16 years-old. A sample of 1103 participants (539 girls) from 7 to 16-years of age, were tested on the MCA and on the 20-m shuttle run test (PACER), and had their weight and height measured. All values were normalized according to age and sex. Relationship between these variables were analyzed by bivariate correlations. ANOVA analyses were

applied to contrast the MC level between three weight status conditions (normal weight, overweight, and obesity), and three cardiorespiratory fitness (CRF) conditions (low CRF, average CRF, and high CRF). Results show a gender diversity on the relationships between MC, WS and CRF. Linear correlation between total MCA and BMI was nonexistent for girls ( $-0.01$ ), and very low for boys ( $-0.19$ ), but returned moderate values between MCA and CRF (0.41 and 0.46 for girls and boys). Boys showed stronger relationships between CRF and locomotor and manipulative components, while girls had a stronger correlation between stability and HRF. Nevertheless, when divided according to weight status, normal weight boys and girls showed significantly better MC levels than their overweight and obese counterparts, and the same happened for the group of high CRF when compared with average or low CRF groups. Different MCA components had different association profiles with BMI and CRF, showing that MC should be treated as multivariate trait composed of stability, locomotor, and manipulative components, as presented in the MCA assessment. Funding source: European Regional Development Fund.

#### **“Learners” and “non-learners” use visual anticipation during the learning process of a contingency learning paradigm in infants**

*Marcelo Rosales, University of Southern California; Jose Carlos Pulido, Universidad Carlos III de Madrid; Nina Bradley, University of Southern California; Maja Mataric, University of Southern California; Beth Smith, Children’s Hospital Los Angeles*

An examination of visual behavior during a motor learning paradigm can enhance our understanding of how infants use vision to learn motor skills. The aim of this study was to determine if infants who learned a robot-mediated contingency learning paradigm (CLP) demonstrated visual anticipation on the robot’s reinforcement behavior (clapping) linked with their own leg movements. In this study, learning was defined as a 50% increase in movement of the infant’s right leg during the contingency phase following a baseline period (no contingency). Fifteen infants with typical development (6-9 months) wore eye-tracking equipment for recording their gaze as they sat supported facing an infant-sized humanoid robot. A sensor placed on their right ankle recorded their leg movements and activated clapping by the robot (contingency reinforcement). The video frame by frame analyses identified gaze shifts that preceded (predictive), occurred (reactive), or did not occur (non-looks) in response to robot reinforcements. A Wilcoxon signed ranked test was used to test whether the proportion of predictive gazes was statistically different from random chance (i.e., 33.3% for 3 types of gaze). A Wilcoxon ranked sum test was used to test if the gaze behaviors differed between learners and non-learners. Results showed that 6 infants learned the contingency and anticipated robot kicks at greater than random chance ( $p = 0.028$ ). Gaze shifts preceded the robot kick by 0.31 sec (median). Learners and non-learners had similar visual and motor behavior during the contingency, but learners moved less during the baseline period ( $p < 0.01$ ). Defining learning based on baseline performance may misclassify participants due to similarities in visual motor behavior while engaged in the contingency portion of our paradigm. Therefore, we conclude that infants try to learn the paradigm through using visual anticipation and further work is needed to examine if visual anticipation results in retaining the learned connection between the infant’s behavior and the reinforcement. Funding source: National Science Foundation.

#### **Examining patterns of explicit and implicit learning during a contingency learning paradigm in infants**

*Marcelo Rosales, University of Southern California; Jose Carlos Pulido, Universidad Carlos III de Madrid; Nina Bradley, University of Southern California; Maja Mataric, University of Southern California; Beth Smith, Children’s Hospital Los Angeles*

Learning in contingency learning paradigms (CLP) in the infant literature has historically operationalized learning as the increased production of a reinforced behavior. In this study we examined the visual-motor patterns of infants during a CLP for evidence of explicit and/or implicit motor learning strategies. Thirteen infants with typical development (6-9 months) were seated in front of an infant-sized humanoid robot that was programmed to clap to reinforce the infant’s right leg movements. The session (12 min) was video recorded and analyzed frame-by-frame to identify the type of gaze (predictive, reactive, no gaze) and number of gazes for each 1-minute block of the recording. Consistent predictive gazes were considered evidence of explicit learning (EL). An increase in robot claps in at least one of block after the EL was identified as evidence of implicit learning (IP). Results showed that all infants exhibited EL. Eleven infants (85%) displayed IL during the next block. Two infants (15%) did not exhibit IL after the EL. However, these two infants did increase overall kicking throughout the recording. These results provide evidence that infants, like adults, may utilize both explicit and implicit learning during a CLP. The two infants who did not exhibit IL following an EL event may have been using both learning strategies in unison. Together, these results indicate that like most motor learning paradigms, there are two types of learning to be examined in infant CLP’s. Pediatric clinicians therefore should focus on establishing behavioral connections during early learning and then focus on motor practice in the later phases of learning. Funding source: National Science Foundation.

#### **What matters most for children with intellectual and developmental disabilities: Time spent in physical activity or physical activity with others**

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On average, children with intellectual and developmental disabilities (IDD) do not meet the daily recommendations of moderate-to-vigorous physical activity (MVPA). Increasing physical activity (PA) has been shown to have positive implications on health status but there is a lack of research to understand the factors of enjoyment of PA and social skill development during PA. The purpose of this study was to examine time spent in MVPA, levels of enjoyment of PA, and with whom most of PA time was spent with. Participants included 35 children (25 boys, 10 girls) with intellectual and developmental disabilities (IDD) between ages 7 and 12 years ( $M = 9.39 \pm 1.89$ ). The average BMI percentile of children with IDD was 59.40, with 3 (8.6%) who were considered underweight and 10 (28.6%) who were considered overweight or obese. Time spent in MVPA was objectively measured for 7 days using ActiGraph GT3X accelerometers. The Children’s Assessment of Participation and Enjoyment (CAPE) was used to examine enjoyment during PA and with whom the children participated. On average, children with IDD spent 34.14 minutes per day engaged in MVPA with only 3 (8.6%) of the children meeting the daily recommendation of 60 minutes. Analyzing specifically the PA category of the CAPE, the children participated in an average of 3.5 of 13 activities (0 to 7). However, participation in these activities averaged only once per month. Of the PA the children participated in, an average of 68.6% indicated they very much enjoyed or loved participating in that activity and an average of 55.5% indicated participation in PA occurred with family. This study highlights the need for additional research to understand the importance of enjoyment in PA and the potential for PA to improve both health status and levels of MVPA. Additionally, engaging in PA with others needs to be considered a gateway to improving health and developing social skills and competencies in individuals with IDD as social skills are also required for successful participation in PA.