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Commentary

Clinical observations of adolescent chronic pain with coordination difficulties: Physical and psychosocial implications

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Introduction

Chronic pain is prevalent in 5% to 38% of the pediatric population (Martin & Zeltzer, 2018) costing $19.5 billion annually in the US (Groenewald et al., 2014). The chronic pain experience is impacted, or exacerbated, by biological, psychological, individual, social, and environmental factors (Carter & Threlkeld, 2012). A biopsychosocial model is recommended to understand and guide treatment of chronic pain. At this time, little research has documented the effects of physical comorbidities associated with chronic pain, such as developmental coordination disorder (DCD). A review of the literature suggests many similar traits impacting both those with chronic pain and those with DCD (see Table 1). The aim of this commentary is to provide a brief overview of coordination disorders, explore their potential relevance to and overlap with chronic pain, and present potential research questions to further investigate how these conditions may relate.

Developmental coordination disorder and chronic pain

Developmental coordination disorder (DCD) is the most common diagnosis used to describe children with motor difficulties (Gibbs et al., 2007). DCD affects 2% to 6% of the population (Crane, et al., 2017; Harrowell et al., 2017) and 6% to 10% of all school-aged children (Dewey et al., 2002; Timler et al., 2016). It is a chronic neurological disorder affecting movement planning and coordination due to brain messages being inaccurately transmitted to the body. Adolescents with DCD struggle to perform everyday motor-based tasks at an age-expected level, and deficits persist despite opportunities to acquire and develop the skills (Campbell et al., 2012). DSM-V now classifies DCD not just as a learning disorder, but a neurodevelopmental disorder, with onset of symptoms during early childhood development (American Psychiatric Association, 2013). Criteria for DCD compares individuals to their peer group in the following areas:

- Below average acquisition and execution of motor coordination skills.
- Functional limitation in activities of daily living (ADL), academics, leisure, and play.
- Motor deficits that are not related to intellectual disability, visual impairment, or neurological disorders.

Many adolescents demonstrate a wide range of coordination deficits that impact movement and function; however, most do not fully meet the criteria for a formal diagnosis of DCD, or the available assessments are not sensitive enough to detect the impairments for those with suspected DCD. In these cases, it is common that further difficulties develop or appear later in adolescence or young adulthood causing functional issues (i.e. impairments in ADLs, school participation, social

Table 1
Similar traits impacting chronic pain and Developmental Coordination Disorder

	Chronic pain	Developmental Coordination Disorder
Prevalence	・5-38% (pediatrics)	・2-6% of the population ・6-19% of school-aged children
Physical factors	・Pain ・Decreased physical functioning ・Sedentary lifestyle ・Deconditioned ・Decreased body awareness ・Obesity	・Deconditioned ・Decreased motor planning ・Sensory deficits ・Higher muscle tone ・Pain
Psychological and emotional factors	・Psychosocial adjustment ・Internalized problems ・Mood impairment ・Decreased social support	・Psychosocial adjustment ・Internalized problems ・Mood impairments ・Decreased self-perception ・Decreased social support and social isolation ・Increased rate of psychiatric and substance disorders
School and social factors	・Poor school attendance & outcomes ・Decreased socialization ・Poor academics and concentration ・Low self-esteem	・Attention problems ・Learning difficulties ・Bullying ・Low self-esteem ・Negative peer relationships ・Poor school outcomes

interactions, and leisure activities). Adolescents with DCD or features of DCD have been found to have significantly poorer scores on attention and learning, higher levels of social problems, and higher levels of somatic complaints (e.g. general aches and pains, reports of headache, nausea, or stomachache, fatigue). Similarly, adolescents with chronic pain tend to have these types of comorbidities (Tegethoff et al., 2015), and the addition of DCD may further exacerbate their chronic pain or pain-related disability.

Assessments

Ideally, a simple and consistent means to identify a wide range of coordination issues via standardized assessments for adolescents would exist; however, at this time there is an absence of a gold standard (Crawford et al., 2001; Hands et al., 2015). Currently, few coordination assessments

exist specifically for the adolescent population that effectively capture the DCD diagnosis, especially at the mild end of the diagnostic continuum. Current assessments commonly utilized by physical and/or occupational therapists can be found in Table 2. Although a number of assessments exist for younger children, each has limitations based on age, abilities covered, time required, or areas of focus.

Table 2
Physical and occupational therapy coordination assessments

Test name	Age	Reference
Bruininks-Oseretsky Test of Motor Proficiency-2 (BOT-2)	4-21 years	Dietz et al., 2007
Movement Assessment Battery for Children-2 (MABC-2)	3-16 years	Brown & Lalor, 2009
McCarron Assessment of Neuromuscular Development (MAND)	3 years-young adult	Brantner et al., 2009
Movement Imagery Questionnaire for Children-3 (MIQ-C)	7-12 years or 18+	Martini et al., 2016
Sensory and Integration Praxis Test (SIPT)	4-11 years	Mailloux, 1990
Developmental Coordination Disorder Questionnaire (DCDQ)	8-14 years	Wilson et al., 2000
Clinical Observations of Motor and Postural Skills (COMPS)	5-15 years	Wilson et al., 1992
Strengths and Difficulties Questionnaire (SDQ)	3-16 years	Goodman, 2001
Adult Developmental Coordination Disorders/Dyspraxia Checklist (ADC)	17-42 years	Kirby et al., 2010
Adolescent Motor Competence Questionnaire (AMCQ)	12-18 years	Timler et al., 2016
Tufts Assessment of Motor Performance (TAMP)	6 years-adult	Gans et al., 1988
Zurich Neuromotor Assessment (ZNA)	6-12 years	Largo et al., 2001

Clinical observations and associated implications

Adolescents with chronic pain struggle to participate in daily activities including functional mobility, school attendance, and participation in social and leisure skills. These difficulties are believed to be caused by pain and deconditioning and also could be exacerbated by coordination deficits. Anecdotally, the authors – a physical therapist (RH), a physical therapy assistant (HK), and an occupational therapist (LN) - have noticed that a number of adolescents with chronic pain in their care also demonstrate coordination deficits that impact performance of therapeutic activities and program participation. These deficits include poor proprioception, poor motor planning, decreased organizational skills and awareness, and limited body awareness. Psychologically it also seems that they report less social interaction and poor self-esteem regarding abilities. Case examples to highlight clinical observations can be viewed in the Appendix. Following the biopsychosocial model of pain, our observations and associated implications can be broken down into physical factors, psychological and emotional factors, and school and social factors (see Table 1).

Physical factors

Adolescents with chronic pain present with physical symptoms that limit function including variable and widespread pain, decreased physical functioning, sedentary lifestyle, decreased physical and leisure activity, deconditioning, decreased body awareness, and obesity (Wilson et al., 2010; Ferreira-Valente et al., 2014; Clauw et al., 2019; Kichline et al., 2019). Similarly, adolescents with DCD present with physical factors including widespread pain, heightened pain level perception, higher muscle tone, sensory deficits, decreased motor planning and body awareness, and deconditioning (Fong et al., 2011; Campbell et al., 2012; Stray et al., 2013; Timler et al., 2016; Crane, 2017). Many commonalities exist in the physical presentations of adolescents with chronic pain and DCD. When trialing various standardized assessments (as seen in Table 2) to evaluate adolescents suffering from DCD or chronic pain, the scores are typically unremarkable as the tests are designed to detect impairments in those with the most severe coordination deficits. Despite unremarkable performance on the assessments, they often demonstrate difficulty with motor planning and coordination tasks during therapy sessions (e.g. floor ladder, bilateral coordination skills, picking up of new physical activities they have not learned prior). Therapists working with youth with comorbid chronic pain and developmental coordination issues observe difficulty with motor planning, increased time and cuing required to master a task compared to peers, changes in pace or technique, and visible frustration with tasks.

Psychological and emotional factors

Adolescents with chronic pain also have been found to have significant psychological and emotional factors that impact function including psychosocial issues, internalized problems, mood impairments, adjustment issues, and decreased social support (Youssef et al., 2008; Carter & Threlkeld, 2012; Ferreira-Valente et al., 2014; Clauw et al., 2019). Psychosocial factors may negatively or positively impact function and pain in children and adolescents with chronic pain. Common symptoms include frequent catastrophizing cognitions, poor coping response, beliefs of disability, and poor social support (Jensen et al., 2011). Similarly, adolescents with DCD have been identified as being at risk of social, emotional, and behavioral problems (Piek et al., 2006). Adolescents with DCD report lower perceptions of scholastic competence, athletic competence, physical appearance, behavioral conduct, and have poorer social and emotional outcomes (Dewey et al., 2002; Harrowell et al., 2017). As part of the associated emotional difficulties, adolescents with DCD report lower self-perception and self-esteem in comparison with adolescents without DCD. They also report feeling that they have reduced competency, or ability, and higher levels of anxiety than their peers (Skinner & Piek, 2001). Literature has revealed a link between psychosocial issues and poor motor skills, specifically, a link between internalizing problems (anxiety, depression, and problematic behaviors) and motor skills. Adolescents with DCD demonstrate less enjoyment

in daily activities, less social support and social skills (i.e. social isolation), and victimization (Cairney et al., 2013; Mancini et al., 2016).

School and social factors

Finally, chronic pain contributes to impaired school functioning in multiple domains. Adolescents with chronic pain struggle with school-related function as noted by poor school attendance, decreased socialization, poor academic performance, poor concentration, low self-esteem, reported lower school self-concept, and mood and behavior concerns (Turk et al., 2016; Jastrowski Mano, 2017; Logan et al., 2017). Similar concerns are noted with the DCD population. A study by Dewey and colleagues (2002) identified that those with movement problems are at risk for future problems (as adolescents) with school functioning including attention, learning, and psychosocial adjustment. The mechanisms that lead to worsened mental health outcomes are not well understood; however, it seems that DCD can be a primary stressor, especially in a school environment, and leads to multiple secondary stressors (e.g. negative peer relationships, bullying, low self-esteem). In addition, those with poor motor coordination demonstrated more impulsivity, poorer social communication, lower self-esteem, lower IQ, and lower reports of friendship or social supports (Harrowell et al., 2017).

Discussion and conclusion

Those with chronic pain and DCD demonstrate similar characteristics and difficulties regarding physical factors, psychological and emotional factors and school and social factors. If left unaddressed, there is potential for worse long-term functioning. In addition, while the implications of each condition alone are similar, the comorbidity of both diagnoses may lead to a more challenging treatment course. It is important to understand and address the contributions of each of these factors to overall function. From clinical observations, we hypothesize that many adolescents with chronic pain may have demonstrated prior coordination deficits that act as a primary stressor in the biological component of the biopsychosocial model. If the coordination deficits are not properly addressed, we believe patients may experience exacerbation of pain and reduced function. This hypothesis falls in line with the environmental stress hypothesis that primary stressors can cause adversity in childhood and adolescence which leads to psychological distress (Cairney et al., 2013; Mancini et al., 2016). For example, an adolescent with coordination issues may develop abdominal pain secondary to stress when, compared to peers with appropriate motor skills, they cannot keep up with more advanced activities in gym class or at sports practice. An adolescent with chronic pain and poor body awareness/motor planning abilities may be at higher risk for psychosocial issues and may experience increased difficulty returning to age appropriate functioning. In addition, without appropriate services to manage the underlying issues, an adolescent with DCD may be at a higher risk to sustain a mild acute injury, such as pulling a muscle or spraining a limb, which can perpetuate the cycle of chronic pain and poor functioning. It is also our experience that when adolescents with chronic pain experience an acute injury it tends to result in more significant symptoms and a longer than anticipated healing process. It is necessary to find new ways for home providers, schools, families, and clinicians to identify these problems and address them early before these adolescents experience worsening of symptoms across all domains of the biopsychosocial model and fall into a refractory cycle of poor functioning.

Lastly, because treatment of complex chronic pain is recommended to be provided by intensive interdisciplinary pain treatment (IIPT) services it is important to note that DCD as a comorbid condition may negatively impact active participation in treatment of chronic pain. Age appropriate cognition and focus, organizational skills, body awareness, and motor planning are all necessary skills for participation in a comprehensive pain management service such as IIPT. Clinically, it seems that adolescents in our program, who may also have DCD or suspected DCD, struggle with overall participation without additional cuing and prompting from staff. These factors are also important from a physical and occupational therapy perspective in understanding how challenging therapeutic activities may exacerbate stress,

therefore increasing pain or impacting overall functioning during the program.

This commentary leaves us with some ongoing questions: (1) How can we best identify and treat adolescents with coordination difficulties more thoroughly and consistently? (2) How can we more specifically treat psychosocial variables secondary to both chronic pain and coordination disorders to prevent exacerbation of chronic pain in various settings? (3) What other assessments should/could we use to address both the physical and psychosocial aspects of coordination difficulties/ disorders associated with chronic pain? (4) How could disciplines better collaborate when working with adolescents identified with chronic pain and various coordination issues earlier on to prevent long-term internalization problems, poor function, and worsening of chronic pain?

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Appendix: Case examples of patients exhibiting features of Developmental Coordination Disorder requiring attention in the context of intensive pain treatment

Patient A is a 17-year-old female with amplified musculoskeletal pain syndrome (AMPS), headaches, and chronic abdominal pain who identified as non-athletic and out of shape with a rating of 69/104 on the Adolescent Motor Competence Questionnaire (AMCQ). She identified that she was uncoordinated and weak, did not like gym class, and reported it as a stressor due to expectations of the teacher and having to complete physical activity in front of peers. She stated that she dislikes sports and avoided active leisure activities, preferring more passive activities (i.e. art, drawing). She participated in her school's art club despite poor attendance during the school day. She was school avoidant and as a result was significantly behind in school work. She struggled with completing coursework in a timely manner due to perfectionistic tendencies and avoidant behaviors. Patient A reported that she struggled to keep up with peers physically and sought out peers who preferred to be less active. She liked to be more isolated with physical activity and became easily frustrated when she could not master a skill, especially in a group setting. She had the mentality that if she could not do it well then she would not try to do it at all. She lacked social support and motivation to increase social activity. She struggled to consistently participate in intensive interdisciplinary pain treatment (IIPT), specifically in group sessions. At discharge she continued to struggle recalling program information and to identify ways she was planning to stay physically active. She was still resistant to returning to school and social activities as well.

Patient B is a 14-year-old male with AMPS, chronic abdominal pain, and headaches who identified himself as very athletic and physically fit, with a score of 89/104 on the AMCQ. He had participated with school and club soccer for several years and felt that he was a key component to his team's success. His parents reported similarly that he was a star athlete. While practicing higher level coordination or sports skills in therapy sessions, therapist observations varied from patient and parent reports. Therapists noted that he struggled to motor plan and complete basic sports related tasks (i.e. floor ladder sequencing drills, jogging/running with proper form, attentiveness to pacing, and bilateral coordination skills with which he was unfamiliar). He was highly resistant to running tasks because it caused pain, and he also reported he did not need to run as part of soccer since he was a goalie. When running was observed, poor mechanics were noted. He lacked insight about physical challenges and emotional stressors. His parents reported that after sports practices and games, he would melt down due to pain and be unable to function appropriately until soccer the next day. Therapists and staff observed a few occasions when he struggled to cope appropriately with competitive peer activities if he did not win. Patient B and his mother disclosed that family members (e.g. father) were extremely competitive and highly valued winning. Patient B was generally resistant to learning coping skills as part of the program, stating they were not helpful. When asked, he could not provide examples of these skills or report when he had attempted them. He was school avoidant and struggled to attend full days, tolerating only up to three hours of school each day prior to admission. He had difficulty with social and extra-curricular activities other than soccer. In the program he struggled to pick up on social cues and tended to isolate himself from other boys his age. When planning for discharge he was still resistant to returning to school full-time, struggled to reiterate key components of the program, and was only open to soccer as a physical activity once home.

Note: In both cases, when provided with a new, less familiar, or more challenging physical task we see difficulty with accuracy of the task, an increase in pain complaints, decreased engagement, more avoidance behaviors (e.g. asking extra questions, needing additional breaks), and a decrease in functioning following more stressful activities.