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# Construction and Preliminary Validation of the interRAI 0-3 Developmental Domains

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Abstract

**Background.** With no standardized approach for early assessment of childhood development in Canada, and with a lack of a comprehensive assessment-to-intervention system that amalgamates social, psychiatric, medical, functional, psychological, and environmental constructs, the interRAI 0-3 was developed to support intervention efforts based on the needs of young children and their families. The interRAI 0-3 includes over 650 items that seek clinical information, developmental milestones, and context items regarding the family and social relationships surrounding the child. The newly developed *interRAI 0-3* was most recently evaluated to examine the reliability and validity of the Expressive and Receptive Language and the Gross Motor Scales as well as examine the outcomes of an at-risk subsample of preterm children.

**Method.** Participant data included children and families (n = 640) from 17 health agencies and childcare centres in Ontario, Canada. Data were collected as part of a pilot study using the full interRAI 0-3 assessment. Criterion validity of the interRAI 0-3 was investigated using a matched sample of participants who completed the Ages and Stages Questionnaire, third edition (ASQ-3) (n = 102) independently from the interRAI 0-3 within a 3-day period of time. Upon intake within child and family agencies across Ontario participating in the pilot study, assessors who received training on the interRAI 0-3 began to collect data with the child and family using the above measures. The interRAI 0-3 training included an overview of the form, manual, coding procedures, and practice using case studies. Paediatricians, Psychiatrists, Psychologists, infant therapists, early childhood educators, child and youth workers, child life specialists, and early intervention teams administered the interRAI 0-3, with parents completing the ASQ-3.

**Results.** The Expressive and Receptive Language scale for children aged 20-24 and 24-28 months demonstrated a high level of internal consistency, with Cronbach's alpha reaching between 0.88 and 0.89, respectively. The Gross Motor Scale for children in the 24 to 30-month age interval also demonstrated a high level of internal consistency, with Cronbach's alpha at 0.893. Inter rater reliability of the Expressive and Receptive Language Scale (ICC = .98, [95% CI, .97, .99], p< .001) and the Gross Motor Scale (ICC = .87, [95% CI, .72, .94], p< .001) was obtained for a sample of 23 participants, showing strong agreement between raters on both scales. Pearson's product-moment correlation between the interRAI 0-3 and ASQ-3 language items was considered moderate, $r(100) = .68$, $p< 0.001$, demonstrating a positive relationship between findings on the interRAI 0-3 and the criterion measure. Similarly, the gross motor scale showed a strong positive correlation, $r(102) = .877$, $p< .01$ with the ASQ-3 motor items. There was also a statistically significant association between childhood performance on interRAI 0-3 language milestones and ASQ-3 achievement of items in the communication domain, $\chi^2(1) = 26.65$, $p < 0.001$, whereas the interRAI 0-3 gross motor scale was considered statistically significant after running bivariate analysis against the ASQ-3, $\chi^2(1) = 45.84$, $p < 0.001$. Results of logistic regression for the Language scale show that with an increase in achievement of communication milestones on the ASQ-3, the odds of pass performance on the interRAI 0-3 language items increases by 4.3% (AOR = 1.043, 95% C.I. = 1.027-1.060), and the sensitivity of model was 77.8%, with specificity slightly lower, at 72.9%. Results of the

predictive model also show that with an increase in achievement of gross motor milestones from the ASQ-3, the odds of achievement on the interRAI 0-3 increases by 6.2% (AOR = 1.062, 95% C.I. = 1.040-1.084). Sensitivity and specificity of the model was also calculated, with excellent findings of 89.6% and 84.6%, respectively. A final subset of children born preterm were also examined for their gross motor milestone achievement based on extent of prematurity. The distributions of gross motor scores were significantly different across categories of prematurity $H(3) = 15.520$, $p = .001$. Gross motor scores decreased from 40 weeks' gestation (mean rank = 310.77), to moderate to late preterm (mean rank = 258.96), and to very preterm (mean rank = 234.54), however extremely preterm (mean rank = 236.28) performed comparably to very preterm.

**Conclusion.** The interRAI 0-3 Expressive and Receptive Language and Gross Motor scales were found to be conceptually sound on the basis of exploratory factor analysis. The changing context of the assessor was also evaluated for stability in observation and scoring. Inter-rater reliability for the both domains shows preliminary evidence of agreement between assessors. There were corresponding findings of concurrent validity between the interRAI 0-3 and the ASQ-3 as the comparison measure of child development. Additionally, scores from the interRAI 0-3 on the Expressive and Receptive Language and Gross Motor items were found to have significant positive correlations with the ASQ-3 for children between 0-47 months. Analyses also show that the ASQ-3 strongly predicts outcomes on the interRAI 0-3 Expressive and Receptive Language and Gross Motor items. Analysis of an at-risk subset of children born preterm also show poorer achievement of gross motor outcomes, which is a final measure of known-groups validity. The interRAI 0-3 was developed based on the observed need for a singular assessment that would encompass a comprehensive range of aspects related to child and family risk and linked to clinically relevant and evidence-informed interventions. This is the first study of its kind investigating the psychometric properties of the interRAI 0-3.

Keywords: interRAI; 0-3; gross motor; language; preterm; validation.

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## Summary for Lay Audience

Current assessment of childhood development is routinely done without the use of standardized tools for recognizing precursors of atypicality. The interRAI 0-3 has been constructed for use by all professionals who work with children between 0-47 months of age. The interRAI 0-3 amalgamates information regarding a child's health, development and issues in the environment and uses triggers to identify areas of risk. Action plans are automatically generated for clinicians to enhance the standard of care and triage for better use of resources. This tool has undergone preliminary validation of the language and gross motor domains of the interRAI 0-3, finding strong reliability and validity for use in clinical and non-clinical settings.

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List of Abbreviations

| | |
|---|---|
| ASQ-3 | Ages and Stages Questionnaire, Third Edition |
| ChYMH | *Child and Youth Mental Health* |
| ChYMH-DD | *Child and Youth Mental Health- Development Disability* |
| CP | Cerebral Palsy |
| DCD | Developmental Coordination Disorder |
| EFA | Exploratory Factor Analysis |
| LBW | Low Birth Weight |
| NICU | Neonatal Intensive Care Unit |
| PT | Preterm |
| ROC | Receiver Operating Characteristics |
| SD | Standard Deviation |

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# CHAPTER 1

# INTRODUCTION

Jo Ann M. Iantosca

## 1.0 Background

Researchers, associations and organizations across North America have identified the importance of the formative years, with continuing advocacy efforts aimed at enlisting greater support for this demographic (Kulkarni et al., 2019; Center on the Developing Child at Harvard University, 2016; Shonkoff, 2016; Mental Health Commission of Canada, 2012; McCain, McCuaig, and Mustard, 2011). Although research has been done to validate assessments that measure the developmental needs of young children-in-family, no singular evidence-based assessment has been found that captures the full scope of impact that these early experiences have had, nor do they recommend clinically sound, multi-level and collaboratively developed action plans for treatment (Kulkarni et al., 2019; Center on the Developing Child from Harvard University, 2016). Furthermore, there is no suite of assessment instruments that can provide a health information system to support integrated care from infancy to adulthood.

Construction and validation of early childhood assessment involves a complex investigation into a child's developmental needs as well as the systems surrounding the child, due to the great variability of child maturation (Mash & Barkley, 2014). This process often begins with defining childhood risk factors that may pose a risk to normative patterns of human development, from infancy onwards, such as defining precursors to developmental delay and problem behaviour (Mash & Barkley, 2014). Adverse genetic mutations, prenatal risks such as toxic insult (e.g. substance use), and postnatal exposure to poor family relations (e.g. hostile parenting), and stress and trauma can alter psychosocial and developmental outcomes (Mash & Barkley, 2014). Finally, there is a recognized need to become evidence-informed in decision making regarding service

provision, particularly in approaching the needs of young children (Egger & Emde, 2011; Kazdin, 2005).

*1.1 Prevalence of Childhood Psychiatric Disorders and Developmental Disability*

The prevalence of childhood psychiatric disorders is scarcely documented by developed countries for children under the age of five years. This may be due to the problematic view that childhood disorders do not demonstrate continuity over time due to maturation, delay in development is not considered a formal disability, or that validated and reliable early childhood assessments and treatment are lacking (Lavigne et al., 2009; Miller, et al., 2013). In a recently published epidemiological study, the rate of childhood psychiatric disorders was found to fall between 6.4-7.1%, with the overall rate of comorbidity documented at 6.4% in related studies (Wichstrøm et al., 2012; Lavigne et al., 2009). Nevertheless, between the ages of five to seventeen, that rate doubles to about 14%, and continues to increase to 23.4% into early adulthood (Wadell, 2007; Mental Health Commission, 2012). The most revealing finding is that 70% of all mental health problems begin in childhood or adolescence, thus measurement of disordered symptoms in the early years may lead to advances in understanding the continuity of disorder (Lavigne et al., 2009; Government of Canada, 2006).

There is significant variation in population estimates regarding children with disabilities due to the multiple definitions of what constitutes a disability, as well as the lack of data collected by governments (Miller, et al., 2013). Often this is defined as below typical intellectual functioning (i.e. IQ below 70) and impairment in life skills, however others have also included psychological conditions (Boyle et al., 2011; Miller, et al., 2013). Too, many children before the age of five are not identified as having a disability, rather it

is referred to as a delay (Miller, et al., 2013). In Canada, children with a diagnosed developmental disability, including psychological conditions were reported as 4.5% of the population (Miller et al., 2013). The impact of developmental disabilities is often chronic, and can lead to a lack of autonomy, poor success in school, deficits in executive function, limited language skills, or poor ability to interact with others (Hofsten, 2009; Houwen et al., 2016; MacDonald et al., 2016; Baghdadli et al., 2012; Wadman et al., 2011). The future quality of life of adults with childhood-onset disability is shockingly grim, leading to severe underemployment or inadequate self-fulfillment (Baldridge et al., 2017).

*1.2 Limitations to Current Assessments of Childhood*

Although there are numerous assessments and screening tools that measure the milestones of child development or behaviour, no singular instrument is devised to examine the full ecological environment of the child, include an integrated, longitudinal approach to assessment and intervention, or provide links to evidence-informed care planning for clinicians (Kulkarni et al., 2019; Center on the Developing Child from Harvard University, 2016). The most notable parent completed screens (See Bricker & Squires, 2009; Squires, Bricker & Twombly, 2015; Brothers, Glascoe & Robertshaw, 2006; Dahinten & Ford, 2004) and professionally administered assessments (Carter, Briggs-Gowan, 2005; Reynolds, Kamphaus, 2015; Achenbach & Rescorla, 2000; Bayley, 2006) assess children for developmental risks or delay, but fail to integrate issues important to clinicians such as parental substance use, foster care placement, financial crisis, or family and social relations (See Appendix B for instrument comparison). They also fail to assess for other contextual factors such as the child's sleep and feeding, childcare environment, or home environment. Without knowledge of the child and family system embedded within a larger context, the

complete picture of the individual child cannot be assumed. Thus, a gold standard to assessment of child development and mental health is lacking. Moreover, current assessments or screening tools may track the child into school-entry but, children are then transitioned into more context-dependant assessments, reducing the ability to longitudinally assess the child using a core set of items. Although this adds data from new contexts, this also duplicates the need for assessment and burdens the child and family who must repeat responses at intake, particularly for those children who are considered medically complex. Finally, professionally administered assessments of childhood do not integrate care plans for clinician use based on scientifically evaluated scales. Rather, clinicians interpret the outcome measure to inform judgement on relevant services or therapy needed for the child. Evidence-informed practice, however, involves providing a link from the assessment to contextualized and scientifically based practices based on outcomes of current interventions in order to enhance the product of care. Together, assessments and screening tools should not stand alone, but follow the child as the context changes, reduce assessment burden, and implement context-dependant and scientifically sound interventions based on item criteria.

*1.3 Construction of the interRAI 0-3*

interRAI is a non-profit collaborative that develops culturally sensitive assessment systems to identify and target the needs of vulnerable individuals across the lifespan. The Child and Youth Suite of assessments targets populations of children who demonstrate mental health challenges or display red flags for developmental delay, as well as supporting the family system. interRAI systems also capture strengths-based information and utilize protective factors to further guide care planning. The development efforts of the interRAI

0-3 included a multi-step peer-reviewed process that involved collaboration with over 90 researchers, policy makers and clinical experts from 35 countries who encompass interRAI. Initially, a central research team conducted rigorous research on current assessments and literature on child development and psychosocial health, as well as clinical practices relevant to specialists working with young children. Given the complexity and interrelationship among child skill development, a significant amount of time was spent identifying specific constructs to be measured within each domain. New constructs relevant to the early years including the social-emotional, fine and gross motor, expressive and receptive, and cognitive domains were identified. Items from other interRAI instruments were retained or altered based on their relevance to the interRAI 0-3 population. Clinicians from the community, including child psychiatrists, pediatricians, child psychologists, speech and language pathologists, nurses, social workers, physiotherapists, and occupational therapists were consulted and participated in reviewing the new or revised items to ensure that they fairly represented each construct. Once the initial draft of the interRAI 0-3 was completed, an international review of the items was obtained from the interRAI Instrument and Systems Development Committee (ISD). This multi-disciplinary committee of expert researchers, clinicians and test developers across a variety of countries provided feedback for each item, resulting in a revised assessment based on specific measurement and evaluation standards. The items were also designed to consistently integrate with other interRAI assessments for crosswalk purposes. Additionally, an international group of experts in over 15 countries represented by interRAI Network of Excellence in Mental Health (iNMH) was then convened to provide additional feedback on each item and its relevance to very young children ranging from infancy to the preschool

years. As part of this process, consultation from various experts in the area of infant, toddler and preschool development provided additional feedback from the represented countries. The central research team integrated the peer-reviewed feedback, producing a final draft to be used for research purposes (See Appendix E). Development and validation were led by Dr. Shannon Stewart and Jo Ann Iantosca at the University of Western Ontario, Canada.

The *interRAI 0-3* came to contain 19 sections, with 651 items (within the pilot version) intended to assess the developmental and unique mental health needs of children aged 0 – 47 months of age in order to provide care planning to agencies that focus on child wellbeing and early development (see Table 1).

Table 1

*Domain content in the interRAI 0-3*

| Domains | Number of items |
|---|---|
| Identification information | 51 |
| Intake and initial history | 64 |
| Family and social relations | 18 |
| Environmental assessment | 9 |
| Stress and Trauma | 29 |
| Childcare | 9 |
| Medications | 7 |
| Diagnostic and other health information | 75 |
| Prevention, service utilization, treatments | 73 |
| Feeding and sleep | 45 |
| Self-care | 22 |

| | |
|---|---|
| Hearing, vision, language | 67 |
| Gross and fine motor | 75 |
| Socio-emotional development | 25 |
| Child temperament | 18 |
| Behavioural concerns | 25 |
| Cognition | 30 |
| Service termination and discharge | 8 |

Unlike other screeners of childhood milestones (Bricker & Squires, 2009; Brothers et al., 2008), the interRAI 0-3 stands to make major improvements to the area of developmental assessment. InterRAI systems include a data collection form; a user manual; triggers; evidence-informed care plans or Collaborative Action Plans (CAPs); status and outcome measures. The interRAI 0-3 provides unique information tailored to early identification and intervention (e.g., prenatal complications, family and social relations; temperamental characteristics; risks related to development and mental health). It also provides a comprehensive assessment of individual needs with applications that can be used to support decisions related to care planning and outcome measurement. There are compatible items in use across care domains (e.g., mental health, education, adult sectors) that share design features such as a specified observation period or time frame, a focus on observable behaviours, the use of a few, powerful questions to assess areas of need, and use of professional judgment to integrate multiple sources of information. The interRAI 0-3 is compatible with other interRAI instruments across services and sectors (e.g., mental health, education), relevant for all age groups across the lifespan. The interRAI 0-3 is

distinct from other instruments because it integrates a comprehensive, multidisciplinary evaluation of a child's strengths, preferences and needs within a series of Collaborative Action Plans (CAPs). CAPs were developed to inform clinical decision-making as part of the care planning process and alert assessors to an imminent problem or need, identified through endorsement of specified items from the assessment. Protocols incorporate evidence-informed practice, goals of care, care planning guidelines, recommendations as well as international best practice available to assessors immediately after the assessment.

With interRAI in the unique position of having established roots in research and policy, the interRAI 0-3 is intended to address the developmental and social-emotional needs of young children, as well as the systematic requirements of agencies to provide evidence-informed care. The official child and youth suite of instruments currently include the Child and Youth Mental Health (CHYMH), Child and Youth Mental Health-Developmental Disabilities (CHYMH-DD), the Child and Youth Mental Health Screener (ChYMH-S) Child and Youth Self-Report Quality of Life (Stewart, Theall, et al., in press); Family Self-Report Quality of Life (Stewart, Theall, Fry et al., in press) as well as the Pediatric-Home Care (PEDS-HC; Phillips, Hawes, et al., 2015); however, missing from this suite of instruments was an assessment that targeted the needs of children at the age of birth to 3 years 11 months for a wide range of agencies that provide client/family-centred needs-based care. Together, the suite of assessments will integrate information for clinicians to provide care for children and youth. The psychometric properties of the interRAI 0-3 scales have yet to be examined, thus a preliminary analysis of pilot data is presented.

*1.4 Aims of the Three-Paper Dissertation*

This dissertation explains the process of developing and validating an inventive and comprehensive instrument to measure childhood need, namely the interRAI 0-3. Further contributions to the extant literature include evidence regarding typical and atypical patterns of development, and specific deviations in development for preterm and low birth weight infants. This doctoral thesis will discuss the theoretical foundations of child development, construction of the interRAI 0-3 assessment, application of the interRAI 0-3 for select populations, as well as the preliminary validity and reliability of gross motor and language domains. It will consist of five chapters, including an introduction, three publishable peer-reviewed papers, and a conclusion.

The introductory chapter provides a discussion regarding the necessity of comprehensive assessments for young children in the current climate of developmental research, as well as scientific inquiries guiding the proposal. This is combined with a review of the construction efforts of the interRAI 0-3, as well as associated risk and protective factors regarding vulnerable children and their families, and the impact of child disability and mental health.

The second chapter (paper one), will examine the internal consistency, and preliminary criterion validity of the expressive and receptive language domain, from data collected on the interRAI 0-3 and Ages and Stages Questionnaire, third edition (ASQ-3; Bricker & Squires 2009). The third chapter (paper two) will examine internal consistency and preliminary criterion validity of the gross motor domain. The fourth chapter (paper three), will examine the prenatal risks and associations with gross motor outcomes, such as preterm birth, low birthweight, neonatal intensive care unit (NICU) care, and maternal health problems during pregnancy or delivery, based on the interRAI 0-3, as well as

investigate gross motor outcomes based on extent of prematurity. Finally, the closing chapter will summarize the research findings and limitations for the field of early childhood assessment.

*1.5 Theoretical Framework for Development of the interRAI 0-3*

There is a theoretical consensus that transactional models are most relevant while outlining the full range of influence on a child's early development, including the effect of the child on his or her environment (Ollendick et al., 2001; Mash & Barkley, 2014). Transactional models of child development take into account near and distant influences and the interrelated structures between the child and the environment (Sameroff, 2009). This also includes the ways in which a child changes his or her own environment, such as the influence of child temperament on parenting (Sameroff, 2009). Nonetheless, with the empirical difficulty in determining the multitude of risk and protective factors within and outside of the child, as well as maturation of the child, the transactional model has led to complicated and flawed intervention efforts (Ollendick et al., 2001).

Taking into account the numerous and compounding needs of children, a theoretically comprehensive lifespan approach, and empirically sound means of assessment is needed (Ollendick et al., 2001). Assessments ought not to separate developmental domains as separate from the mental health of child and family or assess only for childhood risks without emphasis on protective factors. Unlike other instruments, the interRAI 0-3 amalgamates constructs from the fields of child psychopathology, family studies, sociology, and biology in order to attempt to capture the full scope of influence surrounding the child, and between the child and his or her environment. Bronfenbrenner (1979) outlines distinct, yet interrelated structures that serve to reciprocally influence the

developing child. Fashioning a perception of their environment, children begin to make sense of the world around them through their interactions within and between the micro, meso, exo, and macrosystems.

In Bronfenbrenner's (1979) traditional model, the child experiences his or her immediate environment, the *microsystem*, through dyadic relationships with prominent members of the child's inner circle. The child begins to understand the roles and activities associated with members in each setting. Within this proximate domain, families bear a large responsibility for building caring and affectionate social relationships, alongside providing for the basic needs of the child. Without this direct support and perhaps through damaging early relationships, it is hypothesized that cumulative stressors will mount, providing less stability for the child (Verhulst et al., 2011; Kiernan and Huerta, 2008). Caregiver psychosocial issues, including parental psychiatric problems, poor child-adult interactions, disruptive family and social relationships, family dysfunction and other negative conditions, can lead to a cascade of effects, placing children at high risk for developmental, learning, and mental health problems (Dean et al., 2010). The individual child also interacts by eliciting a response to these social relationships based on their innate temperament and developmental level, sometimes causing caregiver distress (Sanson & Rothbart, 1995; Laukkanen, 2014). Temperamental qualities of children influence parenting strategies and caregiver mental health, resulting in high parental psychological control or low parental affection (Sanson & Rothbart, 1995; Laukkanen, 2014). Substantial correlational evidence has identified risk factors associated with later mental health problems, such as early expression of internalizing and externalizing behaviour and early exposure to life stress, such as poor family relationships and environments (Rutter, Kim-

Cohen, & Maughan, 2006; Shonkoff & Garner, 2012; Hanson et al., 2015). The individual factors of the child, such as his or her behaviour or developmental level, are commonly the target for early identification and intervention; however, assessment of the transactions between dyads within this inner level, and assessment of the larger systems provide a holistic understanding of risk and protective factors.

As the conceptual circle grows larger, the *mesosystem* is made up of several microsystems, connected by interrelations such as between the childcare or agency, and home environment (Bronfenbrenner, 1979). For instance, when the child is exposed to intimate partner violence within the home, he or she may convey these transactions in the form of bullying within other environments such as the school (Baldry, 2003).

Also, indirectly impacting the child are the systems affecting members associated with the child through the *exosystem*. For instance, as parents face pressures at work, or are unable to secure time or social services to care for their at-risk children, familial systems may have a direct impact on the child and his or her environment. This is particularly true of families who have limited financial resources or social supports (Holtz, Fox, & Meurer, 2015). To confound this problem, social determinants, such as living in poverty, is associated with future mental illness and poor health outcomes (Shonkoff & Garner, 2012). These surrounding ecological systems can affect the stress-response system, which can become damaging over time and lead to cellular, behavioural and emotional changes (Hanson et al., 2015; Chartier, Walker, & Naimark, 2010; Jaffee et al., 2007).

The *macrosystem* refers to consistent societal phenomena, such as the value placed on early childhood mental health, education and intervention. Until the last decade, Canadian policy, advocacy work, and funding was less directed towards this demographic

(Best Start Expert Panel on Early Learning, 2007). This changing policy has acknowledged the necessity of stronger educational and mental health related supports (Pascal, 2009; McCain, McCuaig, and Mustard, 2011; Mental Health Commission of Canada, 2012), with improved identification including more coordinated, seamless timely access to services (Ministry of Children and Youth Services, 2014). The *interRAI 0-3* assessment intends to drive this change in orientation so that very young children and their families receive efficient access to care through early identification, prioritization, triaging and integrated assessment with infants, toddlers and preschoolers. This will expand the suite to provide an integrated assessment-to-intervention system that incorporates multiple already existing assessments across the entire lifespan, such as the interRAI Child and Youth Mental Health instrument (ChYMH; Stewart et al., 2015); the interRAI Child and Youth Mental Health and Developmental Disability (ChYMH-DD; Stewart et al., 2016); the interRAI Brief Mental Health Screener (BMHS; Hirdes et al., 2015); and the interRAI-Mental Health (RAI-MH; Hirdes et al., 2002).

Most recently added to the bioecological systems theory, the *chronosystem* is seen as symbolic for the passage of time and life events that further impact upon the developing child and his or her environment (Bronfenbrenner & Morris, 1998). This can be interpreted as child maturation, whereby natural development unfolds, or is disrupted in the case of cumulative stressors or disability. Specifically, children's ecological and individual systems can create stress that accumulate over time and lead to physiological changes (Hanson et al., 2015, Chartier, Walker, & Naimark, 2010, Jaffee et al., 2007). The interRAI 0-3 assessment was designed to be utilized for early identification, with the anticipated benefit of circumventing chronic health and social stress at all levels of the ecological

environment. Due to rapid developmental changes in childhood, there is also a need to assess a child at multiple time points to examine developmental trajectories over time.

*1.6 Research Questions*

Within this dissertation, the following research questions will be examined; *How has the interRAI 0-3 been constructed to theoretically address the complexity of childhood development? Are the proposed interRAI 0-3 age intervals regarding motor and language development considered to have strong reliability (i.e. inter-rater reliability and internal consistency)? Do the proposed interRAI 0-3 domains regarding motor and language development demonstrate strong preliminary findings of validity (i.e. criterion validity)? What prenatal and perinatal risk factors are associated with poor gross motor outcomes for children between 6-47 months of age?* And, *How do children between 6-47 months perform on gross motor outcomes based on extent of prematurity?*

*1.7 Developmental Risk, Childhood Psychopathology and Caregiver Psychosocial Risk*

In utero, there are a number of risk factors facing the developing fetus. Through neurulation, the neural tube develops to form the central nervous system (i.e. the spinal cord and the brain). Due to genetic predispositions, infections, prenatal, perinatal and post-natal complications, or toxic insults, the child may be at risk for several fatal or non-fatal neural defects (Shonkoff & Meisels, 2000). Childhood genetic disorders such as Down syndrome, which is a triplicate copy of chromosome 21, can lead to medical complications such as heart defects, as well as intellectual disability, hypotonia, and significant problems with learning (Shonkoff & Meisels, 2000; Prows, et al., 2013). Furthermore, the phenotypic expression of mitochondrial disorders varies from severe developmental decline, to less complex cases of visual or hearing impairment. Though chromosomal and mitochondrial

disorders cannot be cured, it is well-known that forms of early intervention can support adaptive functioning and quality of life (Prows, et al., 2013; Saneto & Sedensky, 2013).

Compounding on the uterine environment of the developing fetus, prenatal exposure to toxins, such as illicit, or prescription drugs or alcohol can have a profound impact resulting in maternal complications as well as effects on infant health and development, learning and behaviour. For instance, infants exposed to illicit drugs such as heroin prenatally, have higher rates of morbidity, respiratory issues, smaller head circumference and growth potential, and are more likely to be considered premature and of low birth weight (LBW; Bandstra et al., 2010; Finnegan, 2013). Other forms of toxic insult include prenatal alcohol exposure, which can also lead to conditions of Fetal Alcohol Spectrum Disorder. Exposure in utero can cause facial abnormalities, deficiencies in height and weight, neurological problems, intellectual and learning disabilities (Olson et al., 2008). Prescription medications also range in their influence on the developing fetus. For instance, antidepressants are responsible for altering the neurotransmission of serotonin, which may also alter the developing brain of the fetus (Represa & Ben-Ari, 2005). Clearly, differences in development can be impacted by a wide range of genetic and prenatal causes.

Predispositions to childhood psychopathology can include prenatal and genetic factors; however, multiple issues stemming from a child's environment can also trigger an epigenetic response, such as repeated exposure to toxic stress (e.g. caregiver substance abuse, domestic violence, or poverty), or poorly developed caregiver-child interaction (e.g. hostile parenting, poor attachment, or temperament interaction between the parent-child dyad). Though these issues are difficult to separate in early childhood, the interactive effects can be detrimental.

Young children view caregivers as their first means to understand, trust, and explore the world. Constructive childhood attachment to primary caregivers during the early years of life requires a transactional relationship with a consistent and healthy adult that is responsive to a child's expression of caregiving needs (Bowlby, 1977, 1980). It has been theorized that insecure attachments can result in avoidant, ambivalent, distressed, and disorganized behaviours in the young child resulting in problematic interactions between the child and caregiver (Ainsworth, 1978). Caregiver distress can threaten a secure relationship, and as a consequence, a child may not begin his or her understanding of the world from a secure base (Ainsworth, 1978; Bowlby, 1977, 1980). Additionally, temperamental qualities of children also influence parenting strategies and caregiver mental health, resulting in high parental psychological control or low parental affection (Sanson & Rothbart, 1995; Laukkanen, 2014). Definitions of temperament have changed over time, defined as much less stable traits, and accounting for new influences, "[t]emperament traits are early emerging basic dispositions in the domains of activity, affectivity, attention, and self-regulation, and these dispositions are the product of complex interactions among genetic, biological, and environmental factors across time" (Shiner et al., 2012, p. 437). These innate characteristics can affect a child's emotional reactivity and behavioural regulation as well as influence his or her social transactions with others. It is specifically children with temperamental qualities such as impulsivity and low effortful control, high emotional reactivity and avoidance that are most at risk for developing internalizing and externalizing disorders and having difficulties with peers and family (Muris & Ollendick, 2005; Pitzer et al., 2009; Lewis & Olsson, 2011).

Ultimately, proficiency in parenting is malleable, however, it can be affected by mental illness, substance abuse, socio-economic circumstances, and conflict amongst caregivers (Kiernan and Huerta, 2008; Goodman et al., 2011; Verhulst et al., 2011; Leerkes et al., 2015; Jaffee et al., 2007; Rijlaarsdam et al., 2013). Within the context of parenting, caregiver mental illness may increase childhood psychopathology and exposure to adversity (Bandstra et al., 2010; Goodman et al., 2011; Agha et al., 2013). For instance, parents with attention deficit hyperactivity disorder (ADHD) are more likely to have familial conflict, parental hostility, as well as children with significant externalizing problems, despite some gender differences in parental findings (Agha et al., 2013). Indeed, the long-term implications of these interactions are poor self-regulation and affect processing, as seen in neurological and behavioural studies (Hanson et al., 2015). Findings also suggest that parents with mental health problems may increase problematic alcohol consumption and potentially lead to intimate partner violence, and incarceration (Gonzalez et al., 2013; Jääskeläinen, 2016; Wymbs, 2017). When parenting becomes hostile and violent, young children may not learn the appropriate means to regulate their emotions, causing them to appear withdrawn, or react in defiance as they gain autonomy (Campbell et al., 2000). Sadly, as many as 17.3% of children exposed to domestic violence in childhood, will make suicide attempts within their lifetime, as compared to 2.3% of children that are not exposed (Fuller-Thomson et al., 2016). In combination, these conditions place young children in jeopardy of exposure to adversity and maltreatment (Bidarra et al., 2016; Moffitt & Caspi, 2003).

Child maltreatment through all forms of abuse or neglect has lasting consequences extending well beyond childhood. Such children are more likely to experience unstable

conditions such as removal from the home, placement instability in protective care, and future re-victimization (Esposito et al., 2017, 2016; Papalia et al., 2017). Maltreated children commonly deal with internalizing and externalizing problems and engage in high risk behaviour such as alcohol and drug abuse and sex trade work and are at increased risk for incarceration (Ullman et al., 2009; Herrenkohl, 2013; Aherns et al., 2012; Wekerle et al., 2017). Individual characteristics such as personality differences, IQ, and gender, play a role in how childhood symptoms manifest into adolescence (Godinet et al., 2014; Jung et al., 2017). As such, exposure to forms of violence and abusive or neglectful parenting severely impacts the lifetime trajectories of children and youth (Bidarra et al., 2016).

Finally, there is a large ecological web of influence with respect to parenting proficiency, including parental education, available resources and home environment. Economic deprivation, for instance, is associated with a less cognitively stimulating home environment, maternal depressive symptoms, parental stress, and hostile forms of discipline (Rijlaarsdam et al., 2013). The myriad of environmental factors surrounding low socio-economic status makes it difficult to find a direct association between childhood internalizing and externalizing disorders; however, young children raised in such environments tend to exhibit these symptoms at a significant level (Rijlaarsdam et al., 2013). The long-term effects of adverse childhood experiences such as hostile parenting, abuse, neglect, parental substance abuse, or domestic violence considerably increase the chances of poor psychological and health outcomes later in life (Felitti, Anda, & Nordenburg, 1998). These impacts substantiate the need for a comprehensive assessment of environmental factors that impact child development and psychopathology.

### *1.8 Interaction between Risk and Protective Factors*

Despite exposure to genetic and environmental risk factors, there are children who are capable of overcoming adversity. The recent literature suggests that children who are at any form of psychophysiological risk due to difficult temperament, poor parenting, low socioeconomic status or genotype may be able to overcome poor developmental trajectories due to plasticity (Hankin, et al., 2011; Silveira, 2011; Suzuki et al, 2011). Based on a child's ability to meet developmental outcomes similar to peers, Jaffee, et al. (2007) conducted research using the Environmental Risk Longitudinal Twin Study with data from 15,906 twins' experiences of adversity. Life stress included familial issues such as parental mental health, poor parenting skills, domestic violence, parental substance abuse, as well as environmental factors such as neighbourhood crime. Factors such as pro-social skills, IQ, temperament, and reading ability were measured against risk factors. Children who were identified as having low stress, such as one stressor but multiple strengths, were more likely to be considered resilient according to Jaffee's (2007) conceptualization, than children with high levels of stress. Others such as Garmzey (1991) have worked with disadvantaged families in poverty to highlight the intergenerational nature of adverse outcomes and questions how protective factors may buffer against risk. It is, in part, the positive social relationships between children and adults that are found to play crucial roles in improving positive outcomes, supporting brain development and ameliorating problem behaviour (Garmzey, 1991; Hanson et al., 2015; Verhulst et al., 2011).

Nevertheless, when children have multiple stressors, they are less likely to overcome them, regardless of having multiple strengths (Jaffee, et al., 2007; Felitti, Anda, & Nordenburg, 1998). Thus, there is clear evidence to support a cumulative stressors model, whereby the effects of stress and trauma may not be overcome. This brings questions over

the plausibility of children's "differential susceptibility" at an individual level (Duncan, 2014, p. 264). Thus, it has been strongly debated that differential susceptibility has been too freely defined or that analyses used were not rigorous enough (Belskey et al., 2015). Although exponential risk may overcome the benefits of protective factors, individual children with developmental, relational or psychological problems may overcome adversity through positive adaptation (Afifi & MacMillan, 2011; Maggi et al., 2011). It is still crucial to note that "more effective interventions are needed in the prenatal period as well as the first three years after birth to provide needed services for the most disadvantaged children and families" (Shonkoff, 2016, p. 1003). Thus, susceptibility should be evaluated as early as possible as a means for developing targeted care plans for young children.

*1.9 Summary*

The ecological system surrounding a child may impact his or her developmental trajectory. Early childhood exposure to risk factors can lead to detrimental and cumulative risk; however, individual effects may buffer to protect from these risk factors. Developmental and psychiatric disorders are prevalent but understudied in very young children; yet the focus on the formative years is undergoing significant attention from policy makers and researchers globally and locally. Drawing from the parliamentary recommendations of the Ontario provincial government on the Special Needs Strategy, alongside the work of the Ontario Centre of Excellence for Child and Youth Mental Health, great work needs to be done in Canada to identify preventative measures in the early years. Current instruments assessing childhood development are lacking in an ecological approach to assessment, as well as evidence-based care planning linked to triggers for childhood risk. Through the construction and validation of the interRAI 0-3 and

examination of its utility for subpopulations of children, investigation into developmental trajectories can be done with a more comprehensive, systematic approach. Whilst the development of the interRAI 0-3 aimed to examine the compounding epigenetic components that impact child development and well-being, the aim of this thesis is purely to investigate the preliminary validity and reliability of the instrument.

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# CHAPTER 2

## THE INTERRAI 0-3: PRELIMINARY ANALYSIS OF THE PSYCHOMETRIC PROPERTIES OF THE RECEPTIVE AND EXPRESSIVE LANGUAGE DOMAIN

Jo Ann M. Iantosca

## 1.0 Background

Despite our developmental understanding of patterns of child development, there is no standardized Canadian model for evaluating preschool children's milestone achievement in the health, education, or social service sectors (Dosman, Andrews & Goulden, 2012).

Areas of childhood development that are commonly studied include gross and fine motor, expressive and receptive language, cognition and social-emotional development, however, differences in development within and across these milestones can be impacted by a wide range of physical and emotional needs not fully captured during brief surveillance by professionals (Dosman, Andrews & Goulden, 2012). Development within and across these areas can be screened for using milestone checklists and empirically validated assessment tools. Nevertheless, there are limitations to screeners that focus solely on development at one time point and in one context, rather than taking into account the interactive effects of sleep quality, nutrition, traumatic experiences or family relations (Dosman, Andrews & Goulden, 2012). In combination, an instrument that captures the major facets affecting a young child's development may lead to a holistic child and family-centred approach to care, more accurate identification of needs, as well as enhance prioritization to support referrals to more specialized treatment (Kulkarni et al., 2019). The interRAI 0-3 is the newest instrument within the Child and Youth suite of interRAI instruments which uniquely follows the child or youth from birth to age eighteen, providing a longitudinal approach to continued clinical care. The following paper includes an analysis of the reliability and validity of the interRAI 0-3 expressive and receptive language domain

as a precursor for future work on the evaluation of predictive factors, which will later aim to link long-term outcomes to early indicators of developmental risk and protective factors.

*1.1 Theories of Language Acquisition*

Developmental scientists and philosophers have debated the early acquisition of language as innate and developing through maturation, or as a process that occurs through continuous learning. Nativist such as Chomsky (1975) posed that language is innately within the brain's biological structure, and also in the mind. Chomsky provided a rationale for Universal Grammar, which he believes all children develop regardless of language or context (1986). His proposal describes an initial state of early syntax, brought forward by a mental capacity, which matures autonomously over time. Given his mentalist orientation, he focused his study of linguistics on the natural human ability to acquire language, rather than focussing on the meaning, or semantics of language (Chomsky, 1986). His ideas were in direct opposition to empiricists who attempted to explain the external process of acquiring and performing language.

Unlike Chomsky, Piaget's theory of cognitive development was considered empirical in nature. Piaget used a stage theory approach to describe how a child's schema (i.e. organizing structure) must develop for them to categorize and create mental concepts through assimilation and accommodation before engaging in valuable verbal conversation with like age peers (Piaget, 2001). Essentially, Piaget believed that the symbolic understanding of language is reliant on or one with cognition (Piaget, 2001). Most important however, is the role of multiple sensory systems needed to understand concepts and language, joining together the social, cognitive and linguistic realms of development (Piaget, 2001).

Social learning theorists and behaviourists have attempted to justify a learning model from which verbal interactions are scaffolded or reinforced. Interactionists assume that there is internal motivation to communicate with others, rather than external. Vygotsky proposed that a cognitive model of language would not be sufficient alone; that it is the interaction between a child's internal system of thinking and language, and the act of being mediated by others that leads to language development (Vygotsky, 1986). Finally, Skinner's principles of operant conditioning explain that children's non-verbal and verbal language are first reinforced and then motivated by others (Skinner, 1957). For instance, young children may learn that waving their hand to say goodbye will elicit others to imitate their action, leading to an increase in the use of gestural language. Although in apparent opposition to rationalists, this difference in perspective is most justified for children with speech and language delay and is not commonly used to fully understand language acquisition (Dillenburger & Keenan, 2009).

In each case, these self-directed and socially reciprocal theories of language acquisition and performance cannot be considered alone to have explained language development, and none should be viewed as more correct than the other. Relatively, they have built on the understanding of language, and must be carefully understood while assessing language milestones. Division of language assessment into milestones is necessary for empirical evaluation of development, though this does not supersede the interpretation of outcomes as being based on an innate process of the mind or as a learned outcome.

*1.2 Receptive and Expressive Language Milestone Development*

Typical speech and language acquisition require the development of sensory systems, cognitive processing, and social responsiveness to verbal or non-verbal language. Though a newborn cannot categorize language or concepts, this human ability is practiced over time and becomes a database for the production of speech and interaction with others. Infants utilize the earliest form of vocalization by crying. Early in life, vocalizations allow children to engage with and communicate their wants and needs to a caregiver. Infants begin to express a greater range of emotions, coo or gurgle in response to objects and people, and become soothed by the primary caregiver (Bricker & Squires, 2009). These vocalizations set a foundation for strong attachment to a responsive primary caregiver, and further increase the likelihood of self-regulation, positive peer relationships and future success in school (Panfile & Laible, 2012; Denham et al., 2012; Goodman et al., 2011; Oller et al., 2013; Jensen, Helder, Gunnoe, 2016). As children develop, they advance in their basic speech and use words to help them make requests, show affection or pride, and it is between 12 and 24 months that children's ability to understand and communicate begins to surface (Dosman, Andrews & Goulden, 2012). A toddler's vocabulary gradually increases to short phrases and is better understood by others over time. Receptively, toddlers begin to examine the facial expressions of others, and follow verbal directions (Dosman, Andrews & Goulden, 2012). Moving into the preschool years, children are able to use more complex sentences to describe stories and events and use their language abilities for example, to negotiate or re-enact scenarios during role play (Dosman, Andrews & Goulden, 2012). Although progression of milestones for language are well documented,

there is also great variability in the development of expressive and receptive language from childhood into adulthood.

Speech and language impairment have been deemed as a condition of high global prevalence (McLeod & Harrison, 2009). In Canada, between 5-10% of children from birth to age four had a speech disorder, with language disorders affecting 2-5%, voice disorders in 6% of the population, and stuttering in 2-5% (CALSPA, 2005). A study of 513 at-risk preschool children from the US found prevalence rates for severe language delay (i.e. 2 SD below the mean on the Preschool Language Scale, Third Edition) was at least 10% of the sample (King et al., 2005). However, up to date population estimates are lacking in many countries, and prevalence rates change based on the specific categorization of the language disorder (Raghavan at al., 2018; McLeod & Harrison, 2009). Additionally, childhood disorders of language become more evident into the preschool years as children's language and communicative skills typically become more advanced, making them more likely to undergo screening later in childhood (Baghdadli et al., 2012; Pimperton & Kennedy, 2012; Wadman et al., 2011). Many children also overcome early language delay, whereas others are diagnosed with language problems later into the school years (Reilly et al., 2010; Armstrong et al., 2016). Larger sample sizes are typically more common once children reach school age (McLeod & Harrison, 2009). Given the variability of milestone achievement and high prevalence of children with language disorders, there should be increasing focus on identification and speech and language intervention services across the lifespan.

The etiology of speech and language disorders can be seen as due to biological or unknown effects. For instance, children with hearing impairments may have delayed

speech and language, impacting the age at which they begin to vocalize (Pimperton & Kennedy, 2012), however such groups may use augmentative communication or sign language to compensate. Additionally, children with developmental disabilities may be delayed in non-language domains, leading to reduced speech and language skills (e.g. cognition) (Mason-Apps et al., 2018). Common predictors for speech and language problems include family history of speech or language problems, internalizing behaviours at age 5, low socioeconomic status, low levels of parental education, and potentially the unmeasured characteristics of mothers who smoke during gestation (Reilly et al., 2010; Armstrong et al., 2016). Given the window of critical and sensitive periods for language development, research on predictors of language delay is needed to inform measures that comprehensively assess children (Shonkoff et al., 2000). Regardless of known etiology, speech and language difficulties in childhood have been associated with poor immediate and long-term outcomes, including limited performance on language-related tasks, externalizing and internalizing behaviours, reduced cognitive outcomes, and poorer educational achievement (Wang et al., 2018; Thurm et al., 2018; Rescorla, 2009; Lewis et al., 2015; Hohm et al., 2007).

Early intervention is therefore context dependent, denoting that the ability to achieve success in an area of language depends on one's biological and ecological circumstances. In a recent longitudinal study predicting the future language outcomes of typically developing infants (10 months) and infants with Down Syndrome (19 months), authors found that non-verbal mental ability (i.e. recognition) and responding to joint attention predicted later language outcomes for children with Down Syndrome (Mason-Apps et al., 2018). This is in contrast to typically developing children, with whom speech segmentation

and initiating joint attention led to later language outcomes (Mason-Apps et al., 2018). This helps to establish an argument for different processes involved in the acquisition of language for children with Down Syndrome due to the interaction of social and cognitive skills with children's language abilities. This also expands on knowledge of phonemic development for typically developing children, and the importance of social initiation to more strongly reinforce later vocabulary (Mason-Apps et al., 2018). For children with behavioural concerns, language intervention has also shown impressive results on reducing behavioural presentation based on parent report (Curtis et al., 2019).

All things considered, the trajectory or language milestones differs for children with speech and language impairments regardless of biological or unknown origins, and many children will naturally unfold in their development without concern. However, given the longitudinal impact and documented prevalence rates, speech and language require early monitoring to locate impairment in an effort to prevent future decline.

**2.0 Present Study**

The development of the *interRAI 0-3* has been conceptualized as a needs-based integrated assessment-to-intervention system that amalgamates social, psychiatric, medical, functional, psychological, and environmental constructs to evaluate and intervene based on the needs of young children and their families. Although in the pilot stage, the authors of the interRAI 0-3 intend to provide a comprehensive assessment for family support centres, as well as other agencies responsible for the welfare of young children. Like other interRAI assessments, as part of the future development of the interRAI 0-3, various stakeholders will be able to use the *interRAI 0-3* to make objective decisions about resources for system-wide planning, outcome measurement, and quality initiatives. The

*interRAI 0-3* has been designed to flow seamlessly into other interRAI instruments, providing a lifespan approach to assessment and care planning. The interRAI 0-3 carry over 200 items from the other assessments in the Child and Youth suite. In particular to this study, data has been collected from agencies that support the developmental and mental health of young children across Ontario to assess the inter-item reliability of the embedded scales on the interRAI 0-3, as well as the inter-rater reliability between trained assessors using the interRAI 0-3. Clinicians completed additional criterion measures which measure relevant constructs in order to evaluate the criterion validity of the interRAI 0-3 scales. The present study investigated the following research questions, *Are the proposed interRAI 0-3 items regarding receptive and expressive language development considered to have strong reliability (i.e. inter-rater reliability and internal consistency)? Do the proposed interRAI 0-3 items regarding expressive and receptive language development demonstrate strong preliminary validity (i.e. criterion validity)?*

## 3.0 Methods

### *3.1 Participants*

Participant data included children and families (n = 640) from 17 community-based health agencies and childcare centres in Ontario, Canada. Data were collected as part of a pilot study using the full interRAI 0-3 assessment. The interRAI 0-3 includes over 650 items that seek clinical information, developmental milestones, and context items regarding the family and social relationships surrounding the child. Embedded in the interRAI 0-3 are scales developed to trigger risk algorithms, as well as Collaborative Action Plans (CAPs), that provide care planning support for agencies. Criterion validity of the interRAI 0-3 was investigated using a matched sample of participants who

completed the ASQ-3 (n = 102) independently from the interRAI 0-3 within a 3-day period of time. This study was approved by the University of Western Ontario ethics board (REB # 108024).

*3.2 Criterion Measure*

The instrument chosen to validate the *interRAI 0-3* was restricted to the following qualifiers; (1) chosen assessments must be comprehensive, with multiple items across differing age ranges (ages 0 – 47 months) in order to identify children's developmental needs; (2) all assessments should carry high sensitivity and specificity in order to identify children at risk for developmental or mental health concerns; (3) in order to facilitate participant recruitment and retention efforts, each assessment chosen should take assessors no longer than 1 hour to complete, so that the total time for all assessments (including validation measures) is no longer than three hours; (4) preferably, early childhood interventionists and specialists in Canada, or at the participating agencies, commonly use the chosen instruments. In order to select appropriate criterion measures, recently published technical papers and compendiums of various screening tools were reviewed, textbooks that recommend early childhood screening and assessment tools were considered, and early childhood specialists were consulted. The assessment selected for validation purposes was chosen to address language and other domains of development, to support validation of other relevant domains for future study. Consequently, one tool was chosen to validate the expressive and receptive area of the *interRAI 0-3*. The selected instrument was the ASQ-3 as it provides a parent-completed developmental screen of early childhood risk, has been evaluated in numerous studies for its psychometric properties, and altogether support the process of preliminary validation. The instrument chosen is also used or recommended by

practicing clinicians at the participating sites. Additional instruments were reviewed for their relevance to the developmental domains or other areas of the interRAI 0-3 (See Appendix B).

*The Ages and Stages Questionnaire, Third Edition* (ASQ-3) was selected for a number of reasons, including the appropriate age range used for assessment, as the ASQ-3 uses items to assess childhood progression of specific milestones from 1 month to 5.5 years of age (Bricker & Squires, 2009). The ASQ-3 examines childhood development within five domains including, Problem-Solving, Communication, Personal-Social, and Fine and Gross Motor Movement and is commonly used by health care providers, educators and primary caregivers in several countries, including Canada. Lastly, the ASQ-3 demonstrates robust psychometric properties using a representative US sample of 15,138 children within the United States (Bricker & Squires, 2009). Concurrent validity, as represented by measuring the ASQ-3 against professionally run and standardized assessments, ranges from 74% – 100% on the various questionnaires, with 86% overall agreement. The reported sensitivity, or ability to identify children with delays, ranges from 76% - 100%, with 86% overall agreement, and the specificity, or the ability to identify typically developing children, ranged from 70% – 100%, with 85% overall agreement (Bricker & Squires, 2009). Areas important to the present study, include the relationship between the communication area on ASQ-3 and expressive and receptive milestone achievement on the interRAI 0-3, specifically for children between the age interval of 0-47 months.

*3.3 interRAI 0-3*

The *interRAI 0-3* was developed utilizing a multi-stage peer reviewed process by researchers from around the globe. This assessment includes 650 items and 18 proposed

scales based on risk factors associated with early disruption of development from the postnatal stage to the period of school entry. The interRAI 0-3 is integrated with other assessments in the Child and Youth Suite of interRAI assessments and links items longitudinally. The interRAI 0-3 stands apart from other widely used measure, such as the ASQ-3, given the ability to examine a range of developmental and medical needs alongside environmental aspects of child nurturance. No other singular instrument exists that captures the breadth and depth of information about child development.

The focus of this study, however, was on one segment of the instrument, specifically, the Expressive and Receptive Language Domain from the interRAI 0-3. The expressive and receptive language domain assesses the developmental milestones achieved in particular age intervals. This domain focuses on imitation, following directions, gestures as a form of communication across infancy, early sound production, and later speech production into preschool. The presence of these milestones is determined using a 2-point coding structure (*0= No* to *1= Yes*), which is summed to provide a composite score based on the age range completed. For instance, between 28 to 30 months, children are expected to communicate in short sentences, label pictures of commonly known objects, follow directions, respond to simple questions, and communicate using 50 or more words. A perfect score on this age interval would be a score of 5.

**4.0 Procedure**

Upon intake within child and family agencies across Ontario participating in the pilot study, assessors who received training on the interRAI 0-3 began to collect data with the child and family using the above measures. The interRAI 0-3 training included an overview

of the form, manual, coding procedures, and practice using case studies. Paediatricians, psychiatrists, psychologists, infant therapists, early childhood educators, child and youth workers, child life specialists, and early intervention teams administered the interRAI 0-3. Assessors were required to have a diploma or degree in early child development, at least 2 years of work experience with young children, and have received the comprehensive *interRAI 0-3* 2-day assessor training program. Not unlike the other interRAI assessments, the *interRAI 0-3* uses a clinician-rated semi-structured interview format and requires approximately 45-90 minutes to complete depending on case complexity, age of the child and assessor experience. Initial assessments may require additional time due to the novelty of the case. Clinicians were given explicit instruction to use information from multiple sources such as medical documentation where approved, as well as information from the caregivers, extended family, childcare providers or other individuals relevant to the context of the family. If clinicians felt that there was incongruent information based on the report from multiple sources, clinicians were asked to make observational judgements to validate their decisions where possible. Site managers were responsible for participating in communities of practice to support implementation efforts, and address assessor's questions regarding the coding of items. Volunteer assessors that were considered familiar with the interRAI 0-3 were also sought to participate in a study of inter-rater reliability. Raters were scheduled to observe and document their findings in one session with the child and family, and independently code their items. Raters did not have contact with one another after the observation, and all assessments were entered independently into a software system.

**5.0 Plan of Analysis**

*5.1 Internal Consistency*

Based on the data available, properties of items from the 20-24 month and 24-28 month age intervals from the expressive and receptive language domain were analyzed for internal consistency and inter-item correlations. Internal consistency of the interRAI 0-3 scales was established using exploratory factor analysis with oblique rotation (Parsons, 2017). Oblique rotation is recommended when there are correlations among dichotomous items (Finch, 2006). Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Bartlett's Test of Sphericity were then employed to test for factor structure (Parsons, 2017). Following this, Cattell's Scree Plot was employed for visual inspection of eigenvalues (Parsons, 2017). Next, Cronbach's alpha was determined, which is a suitable method for analyzing reliability for multi-item scales (Parsons, 2017; Cronbach, 1951; Nunnally, 1978). Values that were considered moderate to strong (i.e. 0.7 – 0.9) were required to ensure robust internal consistency (Parsons, 2017; Cronbach, 1951). The subsamples of 20-24 months and 24-28 months was then compared to the overall internal consistency of the full sample of children between 0-47 months in order to understand how segments of the data compared with the overall internal consistency of the full domain item set.

Variables within the scales had been developed to theoretically measure language; however, given that the language items within each age range measure different forms of language (i.e. gestural, vocal, receptive), exploratory factor analysis (EFA) with oblique rotation was conducted to examine the factor structure and distribution (Allen, 2017; Flora & Flake, 2017). Factor loadings demonstrate the extent to which a cluster of proposed items within each age range measure the same variable, or from which differing items will remain unrelated.

*5.2 Inter-rater Reliability*

Interrater reliability is the level of agreement amongst independent assessors while evaluating a participant using the same measure (Cohen, 2013; Landis & Koch, 1977; Fleiss & Cohen, 1973). For the purpose of this study, assessors were trained on the interRAI 0-3, and had formal experience conducting assessments with young children. The assessors had no contact during the time of assessment, independently assessed the children, scored the instrument and separately utilized all collateral information to integrate into the assessment. The consistency among assessors scoring within each scale was evaluated using the continuous scores for a subsample of 23 children at various age ranges across the proposed scales. Intraclass correlation coefficient is the most relevant analysis to use with the continuous data from the interRAI 0-3 (Fleiss & Cohen, 1973).

*5.3 Criterion Validity*

Initially, correlations between continuous variables representing the outcomes on the ASQ-3 communication domain and the interRAI 0-3 expressive and receptive language domain were conducted to measure preliminary significance. Following this, analyses investigating the relationship between staff and family concern over language skills, and performance on language items from the interRAI 0-3 and ASQ-3 were conducted.

Criterion validity was further obtained by comparing the classification of children on all language items by the interRAI 0-3 and the ASQ-3. Criterion validity in this case, refers to the predictive relationship between language achievement on the ASQ-3 and interRAI 0-3 (Borneman, 2010). Dichotomous variables were used to examine bivariate associations between the interRAI 0-3 language items and the aligned criterion measure using pass-fail as the scale of measurement. Binomial logistic regression was then used to find a predictive

relationship from the ASQ-3 as the independent continuous variable to the interRAI 0-3 as the dichotomous dependent variable.

## 6.0 Results

### *6.1 Demographics of Validity Study*

The population consisted of 640 children assessed using the interRAI 0-3. The participants fell between the ages of 0-47 months (*M*age = 26.2, SD = 13.06), with 62.2% of male participants (*n* = 398), and 37.8% of female participants (*n* = 242). Of the participating families, 53.6% of caregivers were married (*n* = 343), whilst 26.4% were never married (*n* = 169). Those listed as having partner/significant other was 10% of the full sample (*n* = 64), 7.5% were separated or divorced (*n* = 48), and 2.5% were widowed or unknown (*n* = 16). Only 6.1% of the sample included families in which the child undergoing assessment was under current dispute for custody or child access (*n* = 39). Lastly, 10.2% of children had been removed by CAS between 1 month to over a year ago (*n* = 65).

Nearly 24% of children in the sample were born prematurely (23.9%; *n* = 153), and 11.3% of children were considered low birth weight (*n* = 72). A portion of children in the sample were also placed in a neonatal or pediatric intensive care unit, with 17.5% staying in basic care after birth, 11.9% in specialty care, and 14.8% in subspecialty care for critically ill infants. One or more levels of care may have been provided to the same group of participants, and participants may have been considered both premature and low birthweight.

Participants completed the interRAI 0-3 as a part of a pilot study across 17 sites which provide developmental or mental health services in Ontario. Across the full

sample, assessors reported multiple reasons for referral to their agency, with the ability to select multiple concerns. Developmental concerns (*n*= 453) were determined as the most frequently noted issue, then behavioural concerns (*n*= 206), physical delay or disability (*n*= 175), psychosocial concern (*n*= 162), medical concerns (*n*= 106), prematurity (*n*= 95), global developmental delay (*n*= 80), and concerns regarding child maltreatment (*n*= 17).

For the purposes of investigating criterion validity, a smaller sample of participants who consented to additional measures, were matched by identification number and completed the ASQ-3 (*n* = 102). Of these participants, 59.5% were male and 40.5% were female, with 37.1% of all children born prematurely. A majority of caregivers were married (54.3%) followed by never married (30.2%), 9.5% declared having a partner or significant other, and only 6% were separated or divorced.

*6.2 Distributions of Validity Sample*

The distribution for participants (*n* = 640) for children between 0-47 months (*M* = 39.8, *SD* = 36.5) shows that a majority of children are not meeting receptive and expressive milestones for their age. Achievement is based on the successful passing of the total number of language items based on age range (See Figure 1).

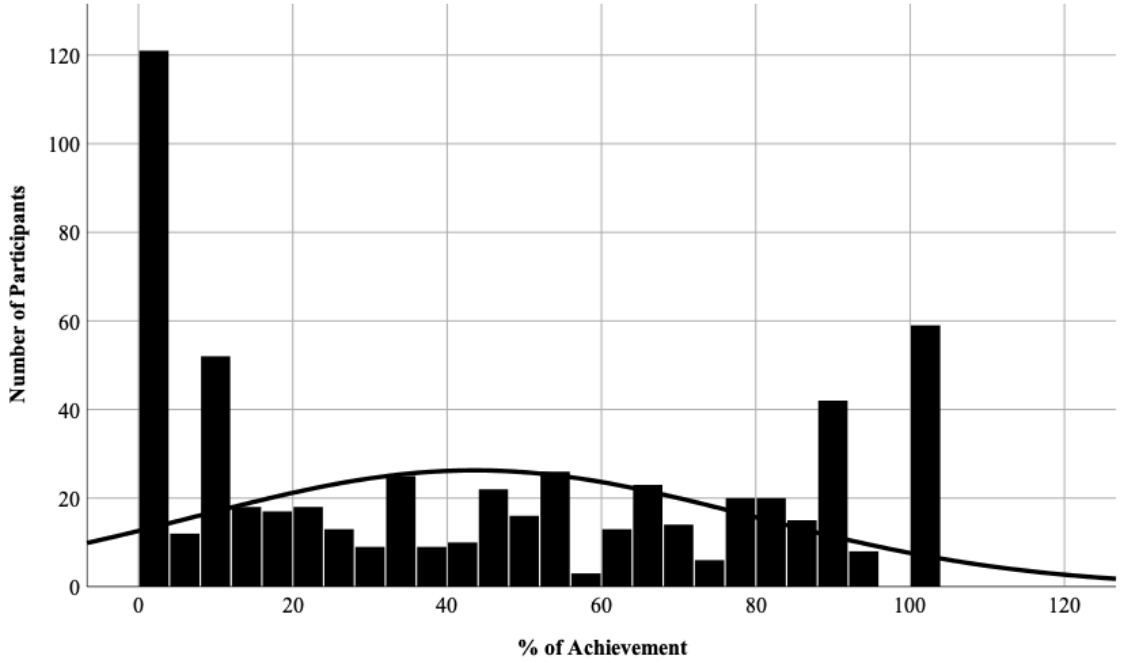


*Figure 1.* Distribution of Language Milestone Achievement (0-47 months).

*6.3 Demographics of Reliability Subsample*

The demographic sample of parent-child dyads with children aged 20-24 months (*n* = 56) and 24-28 months (*n* = 52) are reported for the purpose of investigating factor structure (See Table 2). These age ranges produced the highest sample size for evaluation of reliability, and also measure a critical time point in development of expressive language milestones.

The majority of children between 20-24 months assessed in this age demographic were male (62.5%), and only 37.5% were female. The majority of children were born full term (80.4%), and 17.9% were considered to have had a premature birth. Over 53% of caregivers were married, followed by 28.6% which were never married.

Table 2

*Demographics of children between 20-24 months (n = 56)*

| Variables | Frequency (%) |
|---|---|
| Sex | |
| Male | 35 (62.5) |
| Female | 21 (37.5) |
| Premature birth | |
| Yes | 10 (17.9) |
| No | 45 (80.4) |
| Marital status (primary caregiver) | |
| Never married | 16 (28.6) |
| Married | 30 (53.6) |
| Partner/Significant other | 6 (10.7) |
| Separated/Divorced | 2 (3.6) |
| Widowed | 2 (3.6) |

Similar to demographic data for children between 20-24 months, children between the ages of 24-28 months were mostly male (69.2%), with only 30.8% female. A majority of these children were born full term (75%) and 21.2% were considered to have had a premature birth. The marital status of the caregivers was most commonly listed as married and/or significant other (*n* = 31, 69.2%), with 19.2% never married (*n* = 10), and 11.5% outlined as separated/divorced or unknown marital status.

*6.4 Distribution of Reliability Sample*

The two scales examined included the 20-24 month and 24-28 month age intervals from the language domain of the interRAI 0-3. By utilizing a percentage of achievement score, the mean and standard deviation was calculated by totalling the number of achieved items and dividing by the total number of items in the respective interval.

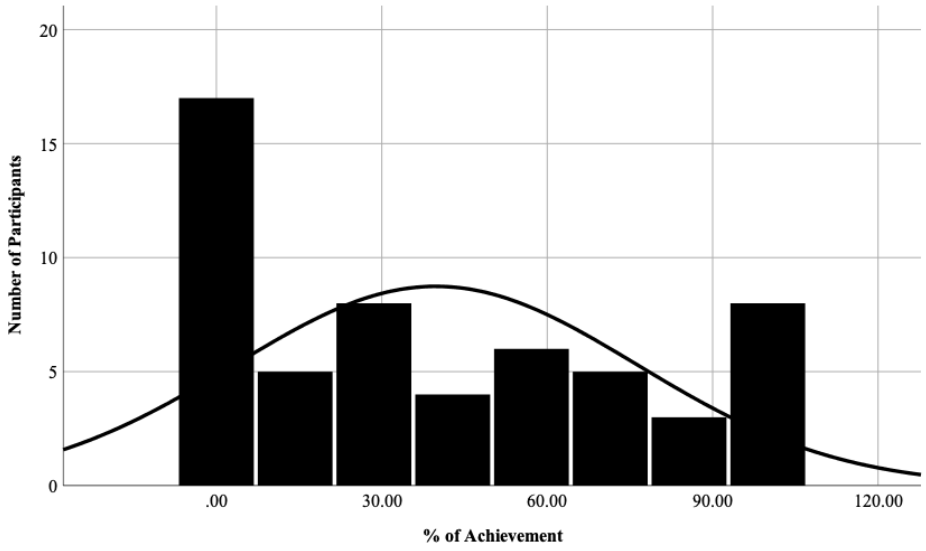


*Figure 2.* Distribution of Language Milestone Achievement (20-24 months)

The achievement distribution for participants in the 20-24 month interval (*M* = 39.8, *SD* = 36.5) (See Figure 2), is slightly different to what was found in the 24-28 month age range (*M* = 28.4, *SD* = 32.8) (See Figure 3), with the mean score lower for the older participant group. Both age intervals included a substantial number of participants who failed the language milestones.

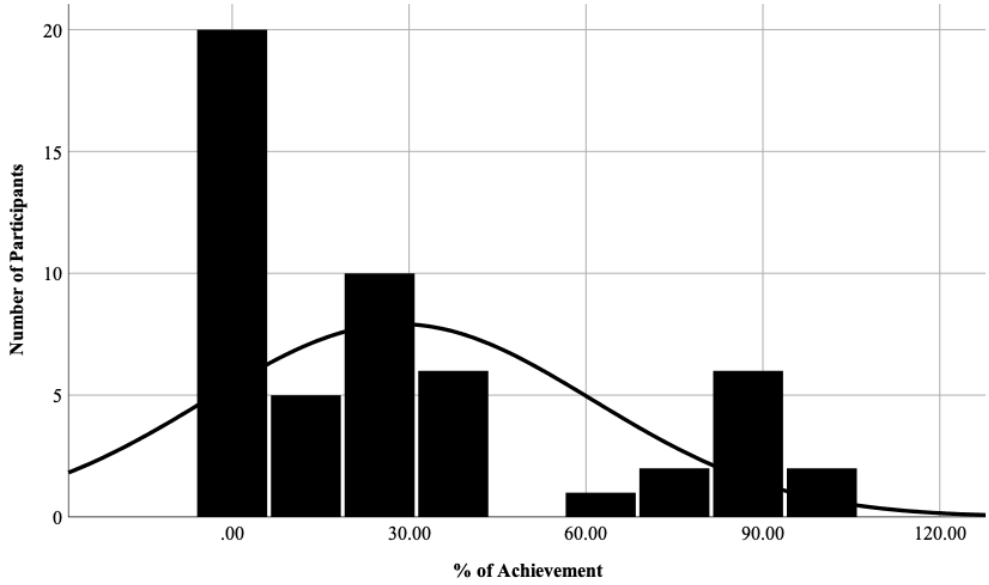


*Figure 3.* Distribution of Language Milestone Achievement (24-28 months)

*6.5 Frequency of Language Milestones*

Frequency scores for children between 20-24 months using the 7-item scale, and for the 24-28 month 8-item scale is displayed in Table 3 and 4 for expressive and receptive language items. A coding of "0" for "No" and "1" for "Yes" was used to display achievement. Some variability in achievement was noted for the two age groups, with some skills that carry forward from 20-24 months to 24-28 months improving, and others showing some decline. Some items also appeared to be more difficult to achieve than others, such as L5oo. Prepositions – uses two prepositions in common language.

Table 3.

*Frequency distribution for expressive and receptive items for 20-24 age interval*

| Items | Pass (1) | Fail (0) | N | % |
|---|---|---|---|---|
| L5cc. Imitation – repeats short sayings (e.g. "nighty-night") | 26 | 30 | 56 | 100 |

| | | | | |
|---|---|---|---|---|
| L5gg. Communicating – combines two to three words or signs into short phrases | 14 | 42 | 56 | 100 |
| L5hh. Labelling – labels pictures of commonly known objects | 24 | 32 | 56 | 100 |
| L5ii. Directions – follows three to four completely verbal directions | 32 | 24 | 56 | 100 |
| L5jj. Communicating – uses 20 to 50 words or signs | 18 | 38 | 56 | 100 |
| L5kk. Responding – responds to simple questions | 12 | 44 | 56 | 100 |
| L5ll. Understandable speech – speech can be understood by an adult at least 25% of the time | 30 | 26 | 56 | 100 |

Table 4

*Frequency distribution for expressive and receptive items for 24-28 age interval*

| Items | Pass (1) | Fail (0) | N | % |
|---|---|---|---|---|
| L5gg. Communicating – combines two or three words or signs into short phrases | 11 | 41 | 52 | 100 |
| L5hh. Labelling – labels pictures of commonly known objects | 25 | 27 | 52 | 100 |
| L5ii. Directions – follows three to four completely verbal directions | 26 | 26 | 52 | 100 |
| L5kk. Responding – responds to simple questions | 10 | 42 | 52 | 100 |
| L5ll. Understandable speech – speech can be understood by an adult at least 25% of the time | 20 | 32 | 52 | 100 |
| L5mm. Communicating – uses 50 to 200 words or signs | 10 | 42 | 52 | 100 |
| L5nn. Personal pronoun use – uses personal pronouns | 9 | 43 | 52 | 100 |
| L5oo. Prepositions – uses two prepositions in common language | 7 | 45 | 52 | 100 |

*6.6 Internal Consistency of Language Items*

Exploratory factor analysis (EFA) was run on a 7-item scale on the interRAI 0-3 that measured the receptive and expressive communication of children aged 20 to 24 months ($n$ = 56). The suitability of EFA was assessed prior to analysis. Inspection of the correlation matrix reveal that all items had correlation coefficients equal to or greater than 0.3 (See Table 5). The overall KMO measure calculated sample adequacy to be "meritorious", 0.88 (Kaiser, 1960; Kaiser 1974) and the total sum of eigenvalues was 7.0. The first eigenvalue shows 59% of total variance (=4.1/7) is explained by the first component. The second component explains only 11.8% of the total variance but is under the eigenvalue of 1 (=0.8/7.0). Cumulatively, the first two components explain 70.8% of the variance, but only 1 factor is retained based on the Mineigen criterion. There were no findings of multicollinearity and the correlations between the items were moderate.

Table 5

*Correlation matrix for language scale 20-24 months*

| Items | L5cc | L5gg | L5hh | L5ii | L5jj | L5kk | L5ll |
|---|---|---|---|---|---|---|---|
| L5cc. Imitation – repeats short sayings (e.g. "nighty-night") | 1.0 | | | | | | |
| L5gg. Communicating – combines two to three words or signs into short phrases | 0.54 | 1.0 | | | | | |
| L5hh. Labelling – labels pictures of commonly known objects | 0.57 | 0.50 | 1.0 | | | | |
| L5ii. Directions – follows three to four completely verbal directions | 0.44 | 0.33 | 0.53 | 1.0 | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| L5jj. Communicating – uses 20 to 50 words or signs | 0.59 | 0.57 | 0.64 | 0.52 | 1.0 | | |
| L5kk. Responding – responds to simple questions | 0.39 | 0.60 | 0.52 | 0.36 | 0.57 | 1.0 | |
| L5ll. Understandable speech – speech can be understood by an adult at least 25% of the time | 0.51 | 0.46 | 0.59 | 0.64 | 0.56 | 0.49 | 1.0 |

Table 6

*Component loadings, communalities (h2) and percentage of variance for principal components analysis language scale 20-24 months*

| Item | Factor 1 | h2 |
|---|---|---|
| L5cc | 0.75 | 0.56 |
| L5gg | 0.74 | 0.55 |
| L5hh | 0.81 | 0.66 |
| L5ii | 0.71 | 0.50 |
| L5jj | 0.84 | 0.70 |
| L5kk | 0.73 | 0.53 |
| L5ll | 0.79 | 0.67 |
| Percent of variance | 5.37 | |

Visual analysis of the scree plot of eigenvalues also shows that the first factor accounts for the most variance, followed by a break before factor two, and minor factors sloping downward, indicating one factor model (Cattell, 1966).

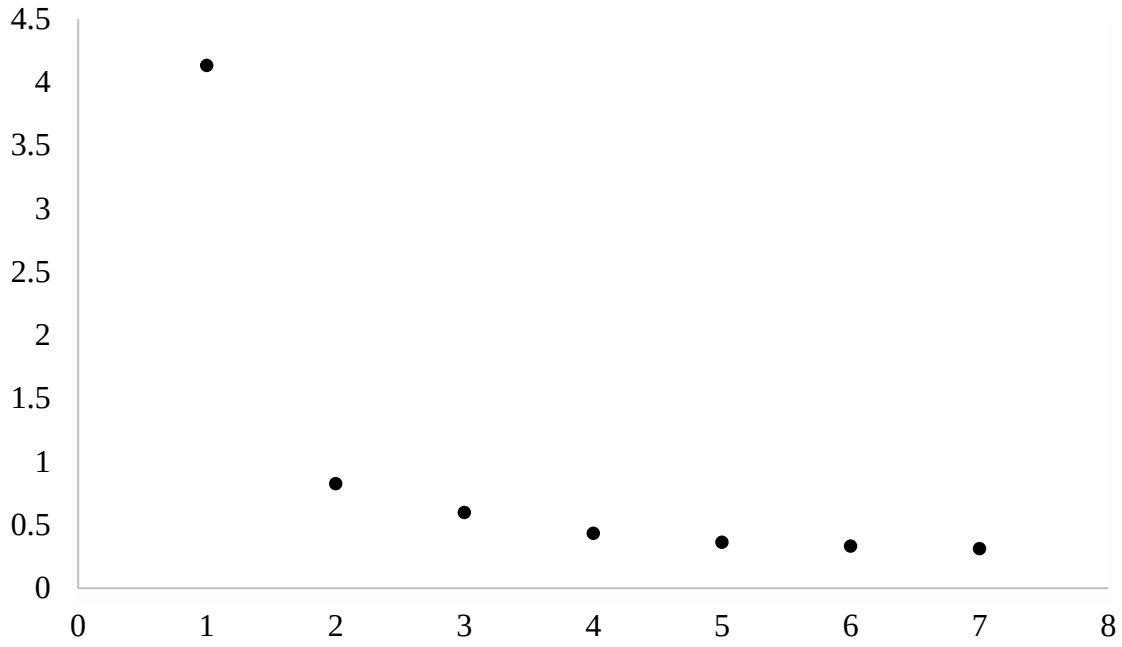


*Figure 4.* Scree Plot of Factors for Receptive Expressive Language Scale (20-24 months)

Next, an EFA was run on an 8-item scale on the interRAI 0-3 that measured the receptive and expressive communication of children aged 24 to 28 months ($n$ = 52) Inspection of the correlation matrix reveal that all items had correlation coefficients equal to or greater than 0.3 other than item L5oo, which was found to positively correlate with L5nn ($p$ = 0.01, $r$ = .028). The overall KMO measure was considered middling (0.78; Kaiser, 1960; Kaiser, 1974), with significance according to Bartlett's Test of Sphericity ($p$ = .005). The total sum of eigenvalues is 8. The first eigenvalue shows 58.7% of total variance (=4.7/8) is explained by the first component. The second component explains only 11.2% of the total variance but is under the eigenvalue of 1 (=.9/8). Cumulatively, the first two components explain 69.9% of the variance, but only 1 factor was retained based on the Mineigen criterion. Based on the results of the statistical analysis, there are no findings that indicate multicollinearity.

Table 7

*Correlation matrix for language scale 24-28 months*

| Items | L5gg | L5hh | L5ii | L5kk | L5ll | L5mm | L5nn | L5oo |
|---|---|---|---|---|---|---|---|---|
| L5gg. Communicating – combines two to three words or signs into short phrases | 1.0 | | | | | | | |
| L5hh. Labelling – labels pictures of commonly known objects | .54 | 1.0 | | | | | | |
| L5ii. Directions – follows three to four completely verbal directions | 0.42 | .58 | 1.0 | | | | | |
| L5kk. Responding – responds to simple questions | 0.70 | 0.50 | .49 | 1.0 | | | | |
| L5ll. Understandable speech – speech can be understood by an adult at least 25% of the time | 0.56 | 0.58 | 0.47 | 5.2 | 1.0 | | | |
| L5mm. Communicating – uses 50 to 200 words or signs | 0.82 | 0.41 | 0.39 | 0.63 | .62 | 1.0 | | |
| L5nn. Personal pronoun use – uses personal pronouns | 0.63 | 0.48 | 0.46 | 0.68 | 0.47 | .55 | 1.0 | |
| L5oo. Prepositions – uses two prepositions in common language | 0.62 | 0.30 | 0.40 | 0.52 | 0.50 | 0.52 | 0.27 | 1.0 |

Table 8

*Component loadings, communalities (h2) and percentage of variance for principal components analysis Language Scale 24-28 months*

| Item | Factor 1 | h2 |
|---|---|---|
| L5gg | 0.88 | 0.77 |
| L5hh | 0.71 | 0.50 |
| L5ii | 0.67 | 0.45 |
| L5kk | 0.83 | 0.69 |
| L5ll | 0.77 | 0.59 |
| L5mm | 0.82 | 0.68 |
| L5nn | 0.75 | 0.56 |
| L5oo | 0.67 | 0.45 |
| Percent of variance | 6.10 | |

Similar to the previous age range, visual analysis of the scree plot of eigenvalues also shows that the first factor accounts for the most variance, followed by a break before factor two, and minor factors sloping downward, indicating a one factor model (Cattell, 1966).

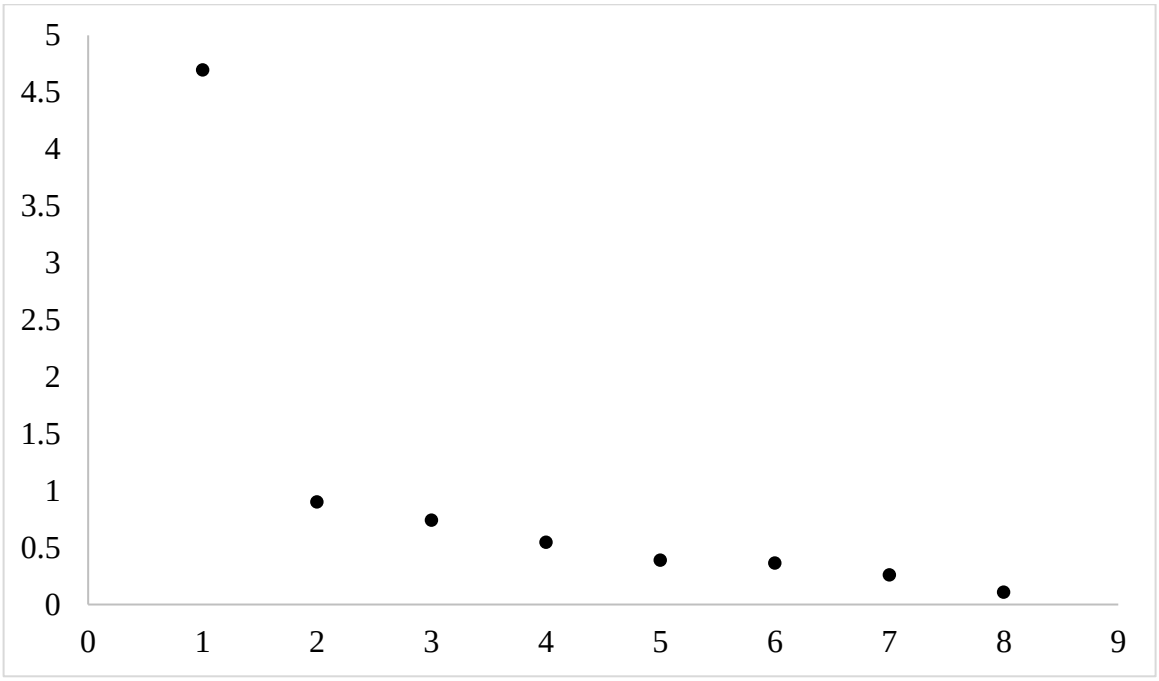


*Figure 5.* Scree Plot of Factors for Receptive Expressive Language Scale (24-28 months)

Finally, the interRAI 0-3 was evaluated for underlying constructs in expressive and receptive language. Both of the age intervals for the language scale had a high level of internal consistency, with Cronbach's alpha reaching between 0.88 and 0.89 for children aged 20-24 and 24-28 months respectively. Cronbach's alpha was not found to increase if any item were deleted, thus the age intervals justifiably retained all items, including L5oo, which was the least significantly correlated. Finally, the full sample of 640 participants who completed the language items within their respective age ranges were transformed into a composite score. Scores on items within each grouped age interval were analyzed, and a Cronbach's Alpha of .73 was found, which is considered moderate.

*6.7 Inter-rater Reliability of the Language Domain Items*

To examine the reliability between rater 1 and rater 2 on the language scales for 23 participants, a reliability analysis was conducted using percentage of achievement based on the participants specific age interval on all language items for children between 0 and 47 months. Given that a continuous variable was used, an intraclass correlation coefficient was most suitable for examining inter-rater reliability, as it is considered an equivalent measure to weighted kappa (Fleiss & Cohen, 1973). There was substantial agreement between the raters' indication of milestone achievement on the expressive and receptive language scale, ICC = .98, [95% CI, .97, .99], $p < .001$.

*6.8 Criterion Validity of the Language Domain Items*

*6.8.1 Correlations with Criterion Measure*

In order to assess the relationship between the total proportional scores from the ASQ-3 Communication domain ($n$ = 102) and the interRAI 0-3 Expressive and Receptive Language domain ($n$ = 640) for children between 0 to 47 months, a Pearson's product-

moment correlation was run. A moderate positive correlation, $r(100) = .68$, $p < 0.001$ was found demonstrating a positive relationship between findings on the interRAI 0-3 and the criterion measure.

Furthermore, correlational analysis between the nominal item, *L4. Family, Caregiver, Friend, or Staff Express Concern About Child's Speech or Language* from the interRAI 0-3, and nominal outcomes of pass-fail on the ASQ-3 communication domain and interRAI 0-3 language domain was also found. Manual definition of item L4 described speech or language concern as, *… it is suspected that the child should have some vocabulary but is not speaking; the child does not follow simple directions; the child is having difficulty with pronunciation when expected not to.* Clinicians were asked to check clinical records where available, speak to multiple informants, such as caregivers, family and staff to gather information about the child's speech and language skills as well as observe the child, to substantiate this item. Clinicians endorsed concern as *Yes* (i.e. 1), and no concern as *No* (i.e. "0"). In response to these findings, a Pearson's product-moment correlation was run, indicating a moderate negative correlation between the item L4 and the ASQ-3 communication pass fail scores, $r(100) = -.52$, $p < 0.001$. Similarly, a small to moderate negative correlation was found between the item L4 and the interRAI 0-3 Language pass fail scores, $r(638) = -.39$, $p < 0.001$.

*6.8.2 Bivariate Associations*

A crosstabulation procedure was used to examine associations between nominal pass-fail scores from items on the interRAI 0-3 and ASQ-3 communication domain. In Table 9, successful achievement of communication items on the ASQ-3 and language items on interRAI 0-3 occurred for 85.2% of the sample, with only 15% of participants

who did not achieve milestones on the ASQ-3 but did so on the interRAI 0-3. Of participants that did not achieve milestones on either instrument, this included 64% of the sample. Only 35.4% of the sample were unable to achieve milestones on the interRAI 0-3 language items but did achieve communication items from the ASQ-3. There was a statistically significant association between childhood performance on interRAI 0-3 language milestones and ASQ-3 achievement of items in the communication domain, $\chi^2(1) = 26.65$, $p < 0.001$. The risk estimate for performing poorly on the interRAI 0-3 as compared to the ASQ-3 was 10.5.

Table 9

*Bivariate association between scores on ASQ-3 communication domain and interRAI 0-3 language Items (n = 102)*

| Variables | Achievement of ASQ-3 Communication Domain | | Chi-square (sig.) |
|---|---|---|---|
| | Yes | No | |
| Achievement of interRAI 0-3 Language Items | | | **26.65 (0.001)** |
| Yes | 46 (85.2) | 8 (15.0) | |
| No | 17 (35.4) | 31 (64.0) | |

*6.8.3 Predicting Language Outcomes*

In order to assess the predictability of the ASQ-3 communication domain items as the continuous independent variable, binomial logistic regression was selected as a suitable method for examining the binary dependent outcome of the interRAI 0-3 language items. Results of logistic regression show that with an increase in achievement of communication milestones on the ASQ-3, the odds of pass performance on the

interRAI 0-3 language items increases by 4.3% (AOR = 1.043, 95% C.I. = 1.027-1.060). The Hosmer-Lemeshow goodness of fit test was calculated and found that model fit was good ($\chi^2$ = .7.91, df = 6, $p$ < .245), and the Omnibus Tests of Model Coefficients found a chi-square value of 38.04, which was statistically significant ($p$ < 0.001). The sole predictor of the model explained 41.6% of the variance using Nagelkerke R Square, and the sensitivity of model was 77.8%, with specificity slightly lower, at 72.9%.

Table 10

*Logistic regression predicting outcome of achievement on interRAI 0-3 expressive-receptive language domain (n = 102)*

| Variables | β | OR | 95% C.I. | P value |
|---|---|---|---|---|
| Expressive-receptive language interRAI 0-3 achievement | 0.042 | 1.043 | 1.027-1.060 | **0.001** |

Finally, ROC curve analysis was used to generate the AUC, showing .842 (.759-.925) based on the percentage of achievement on the interRAI 0-3 by the ASQ-3 binary pass/fail outcomes.

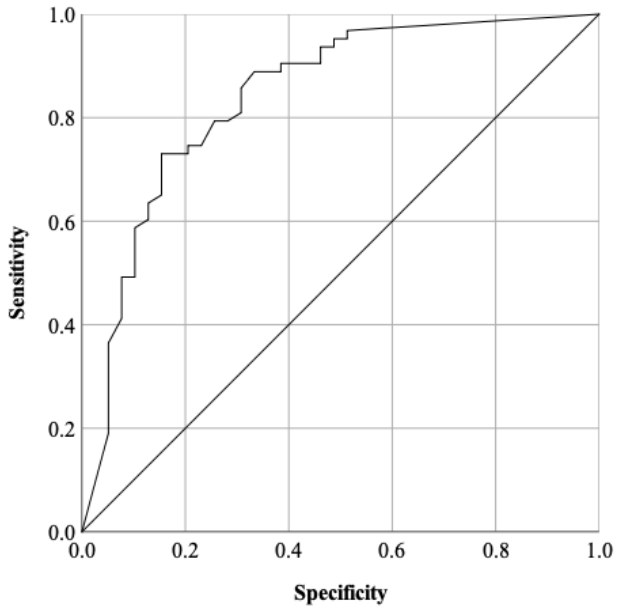


*Figure 6.* ROC Curve for ASQ-3 by interRAI 0-3 Language Domains

## 7.0 Discussion and Conclusion

Given the emphasis on assessment and intervention, the reliability and validity of commonly used instruments is of primary importance for early identification, particularly prior to school entry (Kulkarni et al, 2019). In the present study, the interRAI 0-3 expressive and receptive language domain is evaluated for measuring childhood readiness in the domain of language, which denote milestones for future achievement, including behavioural outcomes, school achievement and cognitive performance tasks (Wang et al., 2018; Thurm et al., 2018; Rescorla, 2009; Lewis et al., 2015; Hohm et al., 2007).

The interRAI 0-3 expressive and receptive language scales for children between 20-24 and 24-28 months were found to be conceptually sound on the basis of exploratory factor analysis and provide evidence for grouping language items by both latent construct and age interval. Cronbach's alpha for both scales was between .88 and .89 respectively,

and overall considered to be good (Cronbach, 1951). Like other assessments that account for child maturation, this approach to evaluating measures has been effective in finding inter-item correlations and discovering latent factors (See Bricker & Squires, 2009; Brothers, Glascoe, & Robertshaw, 2008). According to the findings, the subsets of items that factored together involved performance of listening and attending tasks as well as verbal and non-verbal communication. Items that related to verbal output, such as *L5gg. Communicating – combines two to three words or signs into short phrases* and *L5kk. Responding – responds to simple questions*, were more highly correlated than non-verbal milestones such as, *L5ii. Directions – follows three to four completely verbal directions.* This suggests that although receptive and expressive language form a relationship, stronger independent associations exist within receptive or expressive items. A single factor model was retained for both age ranges (i.e. 20-24 and 24-28 months) since the percentage of variance was strongly predicted as compared to communalities. The only variable considered weak in the model for children between 24-28 months was item *L5oo. Prepositions – uses two prepositions in common language*, which was poorly correlated with *L5nn. Personal pronoun use – uses personal pronouns*. Use of prepositions requires children to understand the meaning of objects that exist in the environment in order to use words such as on, above or under, which is semantically different than pronoun use. Personal pronouns refer to the self, such as I, me or mine, which are much less descriptive and more subjective (Owens, 2001). When assessing language, the intricacies of semantics (i.e. meaning) and syntax (i.e. structure) may be impacting the correlation between these items. A majority of the language items do not examine such particulars of language, but rather children's overall receptive skills, how

large the child's vocabulary is, or how well they are pronouncing words. Both items also appeared difficult for the children in the subsample, with only 17.3% passing and L5nn, and 13.5% passing L5oo. Item difficulty should be examined to ensure that the appropriate age range is being assessed, as these are generally achieved closer to three years of age (Owens, 2001). Regardless, when L5oo was removed from the model, the total variance explained by the first component remained unchanged, thus all items were kept (Boateng et al., 2018). Given that performance of the language items did not increase with age, this must be considered, as it may be negative evidence of convergent validity. The samples within each age interval may have also been challenged with speech and language issues, therefore this is an area that requires further attention. This study did not assess dimensionality using confirmatory factor analysis, which should be done beyond the scope of this pilot study due the power of testable restrictions (Boateng et al., 2018).

The changing context of the assessor was also evaluated for stability in observation and scoring. Inter-rater reliability for the language domain shows preliminary evidence of agreement between assessors (Boateng et al., 2018). Specifically, the concurrent finding between the two raters on the expressive and receptive language items was between .97 and .99 based on confidence intervals, with overall agreement at .98 based on single measures. Precision between raters is considered strong when between .7 to .9, making agreement on achievement of language items highly reliable (Fleiss & Cohen, 1973).

There were corresponding findings of concurrent validity between the interRAI 0-3 language milestones and the ASQ-3 as the comparison measure of child development. The proportioned scores from the interRAI 0-3 expressive and receptive language domain

were found to have significant correlations with the ASQ-3 communication domain for children between 0-47 months. Specifically, correlational analysis revealed moderate agreement of .677 between the scores on both instruments. Both instruments capture the language skills of children, however the magnitude of agreement might be improved by providing more specific examples of communication by the child on the interRAI 0-3, as is provided on the ASQ-3. The ASQ-3 is also a parent-completed measure, thus not accounting for clinician judgement, whereas the interRAI 0-3 is a multiple informant tool recorded by clinicians. Although the interRAI 0-3 takes into account caregiver responses, the final decision of recording achievement of milestones is done by clinicians. Differences between clinician and caregiver rating are a common problem in the literature, however the accuracy of observation of high-risk children is promoted by using parent ratings, moderated by their level of education and SES (Sacrey et al., 2018; Neuhaus et al., 2018). Counter to this, empirical evidence shows that teacher-parent ratings differ substantially but are in stronger agreement when the child is younger (Salbach-Andrae et al., 2008; Achenbach et al., 1987). Finally, the environment in which the child is assessed may also lend to more accurate findings. For instance, a preschool educator or live-in clinical staff who spend substantially more time with the child than a clinician during brief assessment, may lead to differences in recording the outcomes from the assessment (Sacrey et al., 2018; Nisson et al., 2019; Gearing et al., 2015). Thus, dependant on the source(s) of information, accurate assessment scoring and early clinical care received by children who are most at risk for delay may not be received.

Correlational evidence between the dichotomous interRAI 0-3 item asking about staff and family concern for the child's speech and language was similarly associated

with performance on both the interRAI 0-3 [r(638) = -.392, p< 0.001] and ASQ-3 at r(100) = -.521, p< 0.001 for the language and communication measures. This indicates that clinician judgement, in favour of endorsing "yes" to concern regarding the child's speech and language, is highly related to poor outcomes on the criterion measure and interRAI 0-3. The relationship found between the ASQ-3 and *L4. Family, Caregiver, Friend, or Staff Express Concern About Child's Speech or Language*, on the interRAI 0-3 may have been more strongly correlated since the ASQ-3 has been through three iterations of the tool, whereas the interRAI 0-3 may require slight modification to some items in order to increase sensitivity and specificity. For instance, the interRAI 0-3 language items appeared to be difficult to achieve, whereas the ASQ-3 revisions may have led to a stronger cluster of achievable items. Additionally, items from each age interval of the language domain from interRAI 0-3 has not been evaluated for internal consistency, which may reveal that items fit better as a construct under another developmental domain. For example, the ASQ-3 communication domain was evaluated using multidimensional Item Response Theory, and findings revealed that some items fit better in another domain, such as the item which asks if the child points to objects as a form of communication, which fit better under their Personal-Social domain (Chen et al., 2018). Further research across developmental domains will be conducted to determine if this is also the case within the interRAI developmental domains. Additionally, the aggregated totals of achievement within defined age ranges was used in this analysis. Further research to examine correlations between items in each age interval should be examined in relation to the concern item on the interRAI 0-3. Specific age ranges can be explored this way, and there may be a stronger relationship between concern by staff and

family and grouped age-specific intervals on the interRAI 0-3. This will aid in exploring which age ranges need improvement, or if further items are needed to enhance the age interval. Improvements to the interRAI 0-3 might also include rewording items to be more performance based, as is done on the ASQ-3. For instance, caregivers are asked to write down a 2-3 word sentence used by their children, which requires more strict observation of the child. Although this form of correlational analysis validates a known group who is considered "at risk" according to clinician report and based on multiple informants, future research can use outcomes from the expressive and receptive language domain to determine the distribution of scores across other known groups to determine construct validity (Boateng et al., 2018). Known groups may include children who are premature or have diagnosed disabilities. Additional data is needed to obtain larger sample sizes when investigating diagnostic classifications, as categories of childhood disability are not often documented prior to school age.

Bivariate associations between the dichotomous outcomes from the ASQ-3 communication domain and interRAI 0-3 expressive and receptive language domain revealed a significant correlation, thus regression was done to examine the prediction model. Analyses show that the ASQ-3 communication domain strongly predicts outcomes on the interRAI 0-3 expressive and receptive language domain. Sensitivity (77.8%) and specificity (72.9%) estimates show that this model was predictive with respect to all combined age intervals, thus, the interRAI 0-3 language domain can be viewed as a primary area to assess for early identification as compared to the criterion measure. Although the sensitivity and specificity of the language domain of the interRAI 0-3 is sufficient, in order to increase this estimate, item matching can be done through

content analysis of the two instruments across all age intervals. Nonetheless, there may be items on the interRAI 0-3 that measure the scope of language differently, or at different time points. Prospect analysis to review items from the criterion measure and theoretically item-match for scale development as opposed to harmonising achievement based on age range may show promise for increasing sensitivity or specificity but may also reduce items unique to the interRAI 0-3. This should be done alongside analysis of internal consistency to ensure that retained items are also internally reliable. Additional research can also be done to assess the predictive validity of the interRAI 0-3 using present and future outcomes. Future work to collect a larger sample size in order to validate all individual age intervals is also needed. This has been done for other measures of development, where sample sizes are required into the thousands (See Bricker & Squires, 2009).

The interRAI 0-3 was developed based on the observed need for a singular assessment that would encompass a comprehensive range of aspects related to child and family risk and linked to clinically relevant and evidence-informed interventions. This is the first study of its kind investigating the psychometric properties of the interRAI 0-3. The interRAI 0-3 is only one of several integrated and psychometrically sound assessments in the Child and Youth Suite, which collects reliable data to support child and youth outcomes across sectors (See Lau, et al., 2018, 2019; Stewart & Hamza, 2017; Baiden, Stewart, & Fallon, 2017). The interRAI 0-3 pilot study used data from 17 agencies and childcare centres in Ontario that serve the needs of typically developing and developmentally at-risk children and used this data to evaluate the psychometric properties of this instrument. Although other instruments assess the developmental

performance of children at particular age intervals (See Bricker & Squires, 2009), the interRAI 0-3 also integrates risk factors at the child, caregiver and societal level, along with the protective factors that help to buffer these effects. This form of standardized assessment has been recommended as a response to a lack of comprehensive instrumentation that informs treatment planning, and as a means to understand the population of children with developmental and mental health needs in Ontario, Canada (Kulkarni et al, 2019). Although the interRAI 0-3 is not a diagnostic tool, it further meets these recommendations by clinically describing the needs of the child and family system and delivers evidence-informed practices for treatment planning by clinicians and educators (Kulkarni et al, 2019). interRAI is in a unique position to advance these recommendations for our youngest citizens given the link to health information systems and population level outcome measures endorsed by local and international agencies (The Child and Youth Mental Health Lead Agency Consortium, 2019). Quality indicators can also be generated with the data as more becomes available, helping stakeholders to measure and track areas that need improvement. Grouping cohorts based on patterns of assessment outcomes can also support prioritization of services, making interRAI assessments a means to supporting resource allocation as well. The present study evaluated the preliminary reliability and validity of the embedded interRAI 0-3 expressive receptive and language domain as compared to a widely use measure of child development. The prevalence of speech and language disorders and lack of appropriate instruments to investigate language outcomes makes the analysis of the interRAI 0-3 expressive and receptive language domain an important area for validation (McLeod & Harrison, 2009; King et al., 2005; Allen, 2017). Although the outcomes of poor

performance on speech and language measures in childhood can lead to future decline in many realms, validated tools such as the interRAI 0-3 can be used to determine significant risk and properly support early intervention efforts (Dosman, Andrews & Goulden, 2012; Wang et al., 2018; Thurm et al., 2018; Rescorla, 2009; Lewis et al., 2015; Hohm et al., 2007; Curtis et al., 2019). These results imply that as a prospective screener, the interRAI 0-3 language items align well with the criterion measure and are consistent with outcomes from the ASQ-3.

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# CHAPTER 3

## THE INTERRAI 0-3: PRELIMINARY ANALYSIS OF THE PSYCHOMETRIC PROPERTIES OF THE GROSS MOTOR DOMAIN

Jo Ann M. Iantosca

## 1.0 Background

Research to outline patterns of childhood development across domains has been an ongoing effort by medical professionals, instrument developers, and developmental scientists for decades. Providing that progression is not always linear, it can be impacted by the child's environment, and factors within the child (Thelen, 2005). Deviation in milestone progression also has interactive consequences on development in other domains (Leonard & Hill, 2014). For instance, successful motor functioning in childhood is vital for advancing a child's language, social skills, academic achievement and cognition as they mature (Bornstein et al., 2013; Libertus & Violi, 2016; Peyton et al., 2018; Veldman et al., 2019). This is of special attention for children with diagnosed delays resulting from motor or coordination disorders (Lipkin, 2009).

Conventional clinical assessments require surveillance of distinct domains as separate from the other, and do not consider the interactive effects of the child's environment while performing tasks, which is required to fully understand a child's motor development (Dosman, Andrews & Goulden, 2012; Thelen & Ulrich, 1991). The interRAI 0-3 is a newly developed instrument that measures multiple developmental domains, and comprehensively studies the individual within their specific context in order to provide relevant clinical interventions. The interRAI 0-3 is also part of the Child and Youth suite of interRAI instruments, which allows clinicians to follow the progression of the child until the age of eighteen, providing an extended opportunity to evaluate clinical care needs. The following paper includes a preliminary analysis of the reliability and validity of the interRAI 0-3 gross motor domain, as a segment for future analysis of the larger instrument.

### *1.1 Theories of Motor Acquisition*

Researchers and clinicians have theorized that the development of motor skills follows a hierarchy of milestones common to children who are typically developing. Yet, development can be altered due to internal issues to the child such as having physical, sensory or neurological conditions such as Autism Spectrum Disorder (ASD), or Attention Deficit Hyperactivity Disorder (ADHD) (Ament et al., 2015). This progression may also fluctuate based on the task, and the environment surrounding the child. For instance, nutritional intake can be responsible for the body weight of a child, and ultimately impact their motor milestones (Slining et al., 2010). Also, the physical environment such as outdoor play and access to play equipment can influence motor outcomes (Jin et al., 2016). This blend of continuity and discontinuity, stability and flexibility over time is commonly referred to as dynamic systems theory (DST; Thelen, 2005). Thelen's theory has been used to understand discrete motor tasks, particularly for children with issues in motor function. Thelen described the progression of motor skills as complex, but an equal interaction between the physiological, biological and psychological components needed to produce movement. These components will adjust to develop readiness for acquiring discrete motor skills. Some of these components may be working together, rapidly developing at times, whereas reducing capacity at other time points (Thelen, 2005). Furthermore, Thelen explained that a current pattern of development came to be due to its previous history, and that this is working together in time. With this, there is stability in the progression of milestones, however motor skills that advance due to self-determination and influence from the environment are due to finding a more adaptive state (Thelen, 2005). Such an example would be for a child learning to acquire walking as a primary mode of locomotion. As such, DST is a

sufficient ecological lens for assessing development of motor skills in combination with other areas of development, as well as understanding the changes that intervention will have for atypically and typically developing children (Colombo-Dougovito, 2017).

*1.2 Typical and Atypical Physical Milestone Development*

As neonates, typical development first begins with primitive reflexes, such as sucking, grasping, and startling to sound or movement. These basic responses develop prenatally and help infants to thrive outside of the womb. Into toddlerhood, children are far more confident in their physical stability, such as by standing, cruising or even walking about. They have a greater ability to grasp small objects, such as blocks or crayons, and feed themselves finger-foods (Bricker & Squires, 2009; Dosman, Andrews & Goulden, 2012). Throughout the toddler years, they become proficient at walking, running and climbing stairs and strengthen their gross motor skills as they shorten their gait. Their dexterity for tool use, feeding, undressing and dressing activities also improves drastically (Bricker & Squires, 2009; Dosman, Andrews & Goulden, 2012). As preschoolers, children's coordination becomes more advanced and they are better able to support their body on one foot or use outdoor play equipment such as climbing or riding toys (Bricker & Squires, 2009; Dosman, Andrews & Goulden, 2012).

Not all children follow a normative sequence based on standardized tests of physical and motor development. It is to be expected that children with pre-existing developmental or orthopedic conditions will demonstrate atypical motor milestone development as compared to children without these diagnoses. In infancy, delayed reflexes often indicate the need for further assessment of neurological, muscular or sensory disorders (Zafeiriou, et al., 1995; Tudella, Oishi, Bergamasco, 2000; Kondraciuk et al.,

2014). Infants with delayed reflexes due to prematurity or a diagnosis of cerebral palsy are expected to perform more poorly on infant functional assessments and may be postponed in future motor and cognitive milestones as a result of their condition (Marquis et al., 1984; Fiorentino, 1972; Futagi, 2010; Hadders-Algra, 2016). Early indicators can be examined through a number of standardized measures, as well as a neurological exam such as inspecting the child for reflexes, postural control, or any other issues related to muscle tone (Goo et al, 2018). Muscle tone is responsible for a great deal of children's later ability to balance and coordinate their movement and can be found amongst children with several diagnoses including Down Syndrome, cerebral palsy (CP), and developmental coordination disorder (DCD; Goo et al, 2018; Krigger, 2006; de Graaf et al., 2011; Blank et al., 2012). Orthopedic conditions such as cerebral palsy or developmental coordination disorder, are associated with a lack of autonomy as the child ages, impacting dressing and other adaptive skills (Krigger, 2006; American Psychiatric Association, 2013). This can lead to poor success on future school-related tasks, deficits in executive function, as well as limited language skills and poor socio-emotional development (Hofsten, 2009; Houwen et al., 2016; MacDonald et al., 2016). Finally, international studies have also revealed the role that the environment plays in affording opportunities for motor practice. As such, limited access to outdoor play or gross motor toys have been associated with motor impairment (Jin, et al., 2016).

*1.3 Categories of Motor Impairment*

There has been substantial agreement on three major categories affecting movement. The first includes hypertonia, referring to contraction of the muscles and rigidity; the second referring to body weakness, affecting motor planning, postural control and

coordination; and the third, excitable and uncontrolled movements whereby the body moves forcibly on its own (Blackburn et al., 2012). These broad categories aid in understanding the means by which motor function can be impaired or delayed beginning in early childhood, even prior to receiving a formal diagnosis.

Two prominent diagnoses of motor impairment in childhood include cerebral palsy (CP) and developmental coordination disorder (DCD). CP is found to be the most commonly occurring motor impairment in childhood, with international prevalence rates of 1.5 to 2.5 in every 1000 infants; but this often goes undocumented as milder symptoms can go unrecognized (Krigger, 2006; Ontario Federation for Cerebral Palsy, 2011, Korzeniewski, 2019; Robertson et al., 2017). CP is often categorized using the gross motor function classification system whereby functional movement is examined at each time period to observe change in adaptive status from level one through five (Rosenbaum et al, 2008). CP is a neurological disorder and can affect parts or the whole of one's body and/or restrict movement in several ways. The currently agreed upon definition of CP, "[…] describes a group of permanent disorders of the development of movement and posture, causing activity limitation, that are attributed to non-progressive disturbances that occurred in the developing fetal or infant brain" (Rosenbaum et al., 2006, p.1). A lesser form of impaired movement, DCD, is most commonly reported as between 5-6% of children between age 5 and 11 years (American Psychiatric Association, 2013). It is more common for children with DCD to have delayed gross and/or fine motor milestones or reduced functioning that interfere with activities of daily living, or school related tasks that require coordination. However, this diagnosis cannot be identified as due to other

impairments in intellect, vision, or neurological conditions such as CP (American Psychiatric Association, 2013).

Pre-term birth is a common risk factor for motor impairment; such is true of diagnoses including CP (Robertson et al., 2017), and developmental coordination disorder (Williams et al., 2010). Neonates who experience birth complications, such as breeched position, or maternal complications in the period prior to birth also have known effects on motor impairment leading to CP (Robertson et al., 2017), however, the etiology of DCD is less understood. Given the number of children born with motor impairment, the impacts of such disorders are important to consider for assessment purposes and service provision.

**2.0 Present Study**

The *interRAI 0-3* is a comprehensive assessment of childhood health, developmental status, and environmental concerns. Aligned to the assessment are Collaborative Action Plans (CAPs), which are triggered based on a case finding methodology utilizing specific algorithms that indicate clinical need. In this way, the interRAI 0-3 is an assessment that informs intervention efforts, and has clinical relevance for a variety of disciplines such as occupational therapists, speech and language pathologists, psychologists, psychiatrists, social workers, physiotherapists, and child development specialists across agencies that focus on childhood disability and mental health in Canada and across the globe. The interRAI 0-3 is only one instrument in the Child and Youth suite of assessments that crosswalks to older, vulnerable individuals, providing an integrated health information system. All interRAI assessments have direct relevance to agencies and municipalities looking to document the pre-post outcomes of children and evaluate their standard of care,

identify those who require more intensive services, and assist with future program planning.

The purpose of the current study is to assess the internal consistency of interRAI 0-3 gross motor domain and inter-rater reliability between trained assessors using the interRAI 0-3. Individuals participating in the study completed an additional measure with domain criteria related to the interRAI 0-3, in order to report estimates for preliminary validity. The present study investigated the following research questions, *Does the proposed interRAI 0-3 gross motor domain have strong reliability (i.e. inter-rater reliability and internal consistency)? Does the proposed interRAI 0-3 gross motor domain demonstrate strong preliminary validity (i.e. criterion validity)?*

## 3.0 Method

### *3.1 Participants*

Participants completed the interRAI 0-3 as a part of a pilot study across 17 sites which provide care of children, or developmental or mental health services in Ontario, Canada. A total of 640 family-child dyads were assessed using the interRAI 0-3, which examines the child's developmental milestones, mental health, medical conditions, and family dynamics. To test for prediction, a smaller subset of participants completed criterion measures in addition to the interRAI 0-3. Participants were asked to provide up to three hours for assessments, and volunteered information to trained assessors. This study was approved by the University of Western Ontario ethics board (REB # 108024).

### *3.2 Criterion Measure*

Given the comprehensive nature of the interRAI 0-3, multiple assessments were used as criterion measures for other validation studies, however for the purpose of comparison

to the interRAI 0-3 gross motor domain, the Ages and Stages Questionnaire, third edition (ASQ-3) gross motor domain was the primary criterion data collected. The ASQ-3 was selected due to its relevance to the above age ranges, it demonstrates high sensitivity and specificity in order to identify children at risk of developmental delay, it is a screening tool that required limited time by assessors and children, and specialists at the participating agencies are familiar or utilizing the tool in their practice.

The ASQ-3 was evaluated in 2009 using a sample of 15,138 children within the United States (Bricker & Squires, 2009). Concurrent validity was reported between 74% – 100% dependant on the age interval of the questionnaires, with 86% overall agreement. Overall agreement between all domains on the questionnaires indicate levels of sensitivity at 86% and specificity at 85% (Bricker & Squires, 2009).

*3.3 interRAI 0-3*

The *interRAI 0-3* includes items targeting the high-risk developmental needs of infants, toddlers and preschoolers. This newly developed tool retains items from other instruments in the Child and Youth Suite of interRAI instruments but was uniquely constructed to measure the developmental outcomes in language, motor, social-emotional and cognitive domains for children under four years of age. The focus of the present study was to examine the gross motor domain items. The construction of gross motor items began with an extensive review of the literature and common assessments in early childhood, followed by meetings with occupational therapists and other clinicians who work with children with orthopedic impairments. The aim was to develop a set of domain-specific items, which were then reviewed by experts with a consortium of over

90 researchers with interRAI. This was approved for beta-testing of the draft, which forms the basis for this research.

The multi-item gross motor domain assesses the developmental milestones achieved in multiple age intervals. This area of the tool focuses on gross motor milestones for children between 0-47 months, including early mobility in infancy for instance, or the progression of climbing and running as the child matures in age. The presence of these milestones is determined using a 2-point coding structure (*0= No* to *1= Yes*), which is summed to provide a composite score based on the age range completed. For instance, for children between 16 to 18 months, standing without support, lowering and rising from a standing position, walking without support, climbing in a crawling position, and descending stairs with support are recorded as gross motor. A perfect score on items for the listed age interval would be a score of 5.

**4.0 Procedure**

Agencies across Ontario that work with the developmental needs of children began participating in the pilot study on a rolling basis between 2017 to 2019. All assessors were required to have knowledge in early childhood development amounting to a degree or diploma, as well as 2 years of work experience with young children. All clinicians who volunteered to utilize the interRAI 0-3 also received a 2-day training on the ethical procedures, instrument, manual, and implementation while working with young children. Assessors are also reminded about interviewing skills and rapport building with children and families. The interRAI 0-3 implementation requires assessors to interview clients, gather information from multiple sources and record outcomes using an electronic assessment system that generates output for each case. Clinician interviews are semi-

structured to obtain information without reading directly from the assessment, and decisions about rating are based on clinician judgement. The assessment information can largely be collected from sources prior to the interview, and case complexity affects the length of time required for assessment. Time for completion ranges between 45-90 minutes per assessment. Assessors must judge the most correct source of information when conflicting information arises or follow decision trees about coming to particular conclusions.

## 5.0 Plan of Analysis

### *5.1 Internal Consistency*

The internal consistency of the embedded gross motor items for children in the age interval of 24-30 months was evaluated for correlations among items. Although the items were developed to confirm the construct of gross motor development, given variation in the item construct and due to the limited sample size for each age category, exploratory factor analysis (EFA) was used to verify the configuration of the factors for only one age range. Thus, the confirmatory nature of the factor structure was not determined, regardless of the theoretical relationships between the components (MacCallum, Widaman, Preacher, & Hong, 2001). Given the use of dichotomous items that show statistically significant positive relationships, oblique rotation is recommended (Finch, 2006).

Next, Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy and Bartlett's Test of Sphericity were used to examine model variables for proportion of variance and structure. Cattell's Scree Plot was used to visually inspect retained factors that account for the most variance. Lastly, Cronbach's alpha was used to confirm moderate to strong values (i.e. 0.7 – 0.9) for the purpose of determining internal consistency of the multi-item gross

motor scale (Cronbach, 1951; Nunnally, J. C., 1978). The findings of the subsample (i.e. 24-30 months) were then examined in relation to composite scores based on age intervals for full sample (n = 640) of participants between 0-47 months to establish a comparison with the full gross motor domain set.

*5.2 Inter-rater Reliability of Gross Motor Domain Items*

The data for a convenience subsample of 23 children across all reported age intervals was used to indicate any differences or stability in the raters' judgement. Following appropriate training, two independent raters assessed children utilizing the interRAI 0-3 gross motor items, in which an intraclass correlation coefficient (ICC) was used to ascertain level of agreement. The data were examined using continuous variables; thus ICC was a fitting method of analysis (Fleiss & Cohen, 1973).

*5.3 Criterion Validity*

Two correlational analyses were used as an initial evaluation of significance. These included a Pearson-product moment correlation between the percentage of achievement outcome from the ASQ-3 and interRAI 0-3 gross motor domain. Correlational analysis then took place to investigate the relationship between staff and family concern regarding achievement of gross motor milestones, and achievement of milestones on the ASQ-3 and interRAI 0-3 gross motor domain. Finally, correlations were conducted between a composite variable from the interRAI 0-3 with items regarding musculoskeletal and neurological problems affecting the body, such as abnormal muscle tone or cerebral palsy. This variable was then compared to pass-fail items from the ASQ-3 and interRAI 0-3. These methods help to further establish criterion validity of the interRAI 0-3 for populations with possible motor impairment by looking at a known population at risk of

gross motor delay. Criterion validity for the purpose of this study, refers to the ability of the ASQ-3 gross motor domain scores to predict gross motor outcomes on the interRAI 0-3 (Borneman, 2010).

Next, using the criterion sample of children between 0-47 months (*n*= 102), nominal pass-fail variables were assessed for bivariate associations between the interRAI and ASQ-3 gross motor domains. To explore a more predictive relationship between the two measures, logistic regression was used to estimate the odds of the ASQ-3 gross motor domain contributing to achievement on the interRAI 0-3 gross motor domain. The ASQ-3 gross motor domain functioned as a continuous independent variable, whilst the interRAI 0-3 gross motor domain remained dichotomous as the dependent variable.

## 6.0 Results

### *6.1 Demographics of Validity Study*

The present study included 640 children between 0-47 months (*M*age = 26.2, SD = 13.06). The sample consisted of primarily male participants (n = 398), with 242 female participants. The most notable reason for referral was developmental concerns, followed by additional reasons listed in Table 11. Several children were born prematurely (n = 153), and/or low birth weight (n = 72). Parents of the participating children were most often married (n = 343), with only 6.1% of the families in dispute over custody or child access, however 10.1% of children had been previously or currently removed from the home by child protective services.

Table 11

*Characteristics of interRAI 0-3 participants (n = 640)*

| Variables | Frequency (%) | Mean | *SD* |
|---|---|---|---|

| | | | |
|---|---|---|---|
| Age at assessment | | 26.2 | 13.1 |
| Sex | | | |
| Male | 398 (62.2) | | |
| Female | 242 (37.8) | | |
| Premature birth | | | |
| Yes | 153 (23.9) | | |
| No | 487 (76.1) | | |
| Low birth weight | | | |
| Yes | 72 (11.3) | | |
| No | 568 (88.7) | | |
| Reason for referral* | | | |
| Developmental concerns | 453 | | |
| Behavioural concerns | 206 | | |
| Physical delay or disability | 175 | | |
| Psychosocial concerns | 162 | | |
| Medical concerns | 106 | | |
| Prematurity | 95 | | |
| Global developmental delay | 80 | | |
| Concerns regarding child maltreatment | 17 | | |
| Marital status | | | |
| Married | 343 (53.6) | | |
| Never married | 169 (26.4) | | |
| Partner/significant other | 64 (10) | | |
| Separated or divorced | 48 (7.5) | | |
| Widowed or unknown | 16 (2.5) | | |
| Current dispute of custody/child access | | | |
| Yes | 39(6.1) | | |
| No | 601 (93.9) | | |
| Child removed by child protective services (1 month >1yr) | | | |
| Yes | 65 (10.2) | | |
| No | 575 (89.8) | | |

* Note: participants may fall into multiple categories

The full sample of children between 0-47 months was used (n = 640) to examine validity of the interRAI 0-3 gross motor domain, with a smaller sample of participants completing the ASQ-3 (n = 102). The criterion sample included 59.5% of males and 40.5% of females, followed by 37.1% premature children. The primary caregivers were most often declared as married (54.3%) with 30.2% never married, a smaller number of

caregivers reported having a partner or significant other (9.5%), and 6% of all caregivers were considered separated or divorced.

*6.2 Demographics of Reliability Subsample*

Amongst participating children, one age interval was the focus of the reliability study and included children between 24 and 30 months (n = 91). In this sample, 70.3% were male, 29.7% were female, and 15.4% were identified by the interRAI 0-3 as being premature. Some characteristics of the partial sample could not be reported due to low sample size, as per request of the Research Ethics Board.

Table 12

*Demographics of children between 24-30 months (n = 91)*

| Variables | Frequency (%) |
|---|---|
| Sex | |
| Male | 64 (70.3) |
| Female | 27 (29.7) |
| Premature birth | |
| Yes | 14 (15.4) |
| No | 74 (81.3) |
| Low birth weight | |
| Yes | 15 (19.7) |
| No | 76 (80.3) |

*6.3 Distributions of Validity Sample*

The distributions of achievement for gross motor items shows that for participants (n = 640) between 0-47 months, the mean score was 66.60 (*SD* = 37.07). This indicates that a large number of participants were able to successfully achieve gross motor outcomes within their age range.

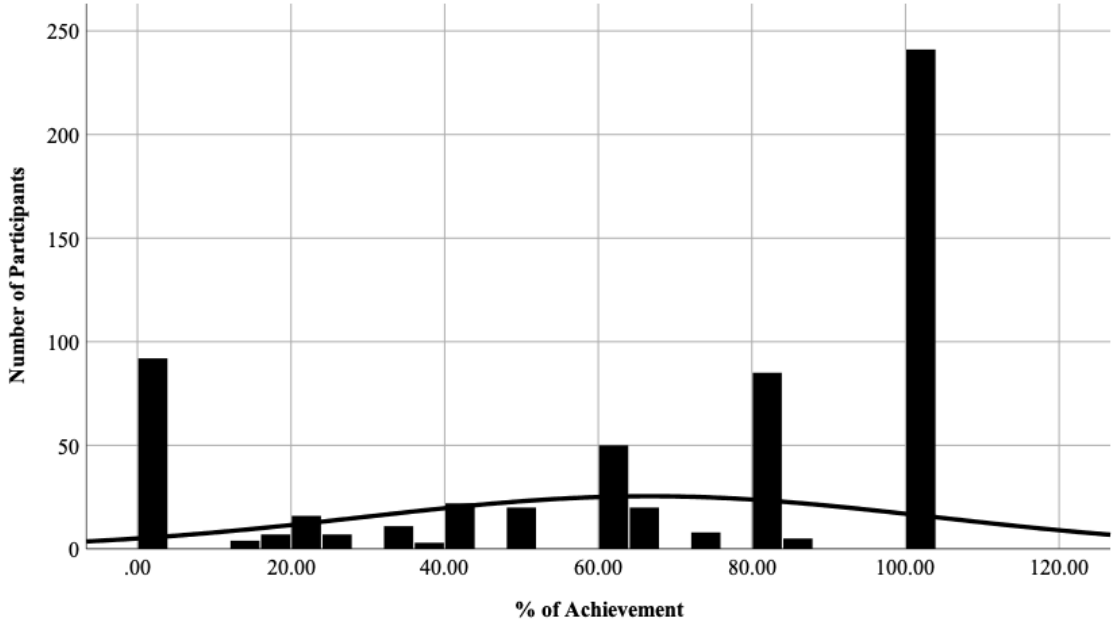


*Figure 7.* Distribution of Gross Motor Milestone Achievement (0-47 months)

*6.4 Frequency Distribution of the Gross Motor Domain*

Frequency distributions for children between 24-30 months using the 5-item scale for gross motor shows that most children were meeting the milestones for their age, which is listed as a score of 1 in Table 13. As the item difficulty of "Climbing" increased from M2ii to M2jj, the ability to meet milestones also decreased.

Table 13

*Frequency distribution for gross motor items for 24-30 age interval*

| Items | Pass (1) | Fail (0) | N | % |
|---|---|---|---|---|
| M2ee. Running – runs with moderate stability | 77 | 14 | 91 | 100 |
| M2gg. Jumping – jumps off the ground with two feet in place | 56 | 35 | 91 | 100 |
| M2hh. Kicking – swings leg forward to kick | 68 | 23 | 91 | 100 |
| M2ii. Climbing – ascends or descends stairs with limited | 72 | 19 | 91 | 100 |

| | | | | |
|---|---|---|---|---|
| support, placing two feet on each step | | | | |
| M2jj. Climbing – ascends or descends stairs with limited support, alternating feet | 52 | 39 | 91 | 100 |

*6.5 Distributions of Reliability Sample*

The reliability sample of children between 24-30 months achieved gross motor items slightly better than the full sample (*M* = 71.4 *SD* = 34.4). Less than 30% of the participants failed milestones in this age interval.

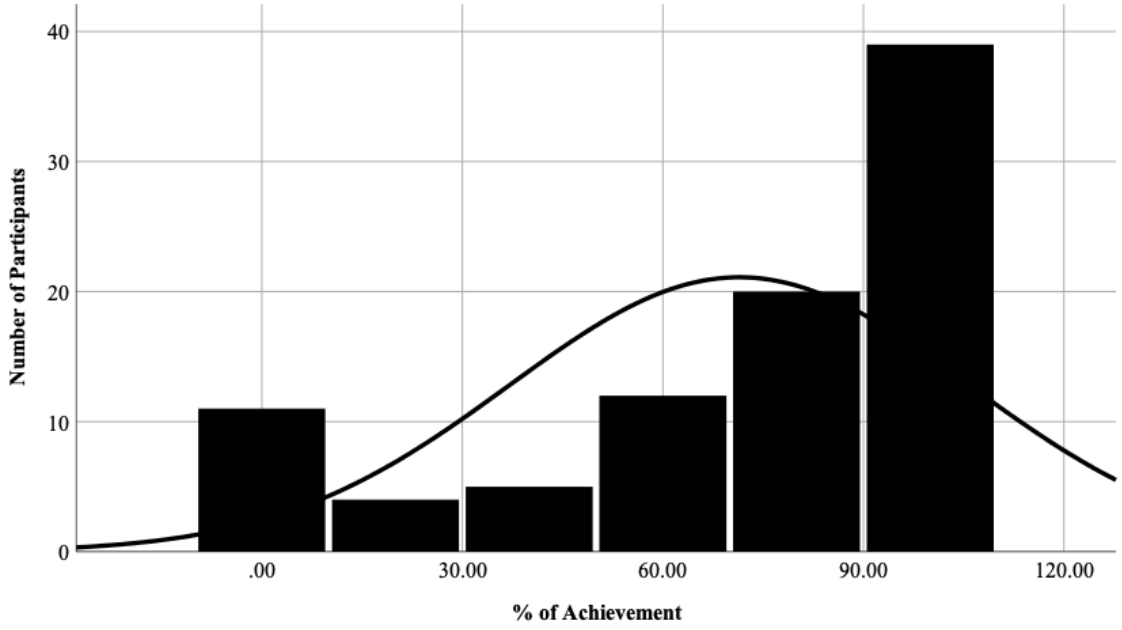


*Figure 8.* Distribution of Gross Motor Milestone Achievement (24-30 months)

*6.6 Internal Consistency of the Gross Motor Scale*

Inter-item correlations are presented for children between the age ranges of 24-30 months in the gross motor domain (See Table 14). Inspection of the correlation matrix for both age ranges reveal that all items had correlation coefficients equal to or greater than

0.37. The overall KMO measure for 24-30 months 0.82, which falls under the category of "meritorious" (Kaiser, 1960; Kaiser, 1974). The total sum of eigenvalues is 5.0. The first eigenvalue shows 62% of total variance (=3.10/5.0) is explained by the first component. The second component explains only 14% of the total variance but is under the eigenvalue of 1 (=0.70/5.0). Cumulatively, the first two components explain 76% of the variance, but only 1 factor is retained. There were no issues with multicollinearity based on the results of this analysis.

Table 14

*Correlation matrix for gross motor items 24-30 months*

| Items | M2ee | M2gg | M2hh | M2ii | M2jj |
|---|---|---|---|---|---|
| M2ee. Running – runs with moderate stability | 1.0 | | | | |
| M2gg. Jumping – jumps off the ground with two feet in place | 0.41 | 1.0 | | | |
| M2hh. Kicking – swings leg forward to kick | 0.59 | 0.58 | 1.0 | | |
| M2ii. Climbing – ascends or descends stairs with limited support, placing two feet on each step | 0.68 | 0.48 | 0.57 | 1.0 | |
| M2jj. Climbing – ascends or descends stairs with limited support, alternating feet | 0.49 | 0.37 | 0.47 | 0.59 | 1.0 |

Table 15

*Component loadings, communalities (h2) and percentage of variance for principal components analysis Gross Motor Scale 24-30 months*

| Item | Factor 1 | h2 |
|---|---|---|

| | | |
|---|---|---|
| M2ee | 0.82 | 0.67 |
| M2gg | 0.71 | 0.50 |
| M2hh | 0.82 | 0.67 |
| M2ii | 0.85 | 0.73 |
| M2jj | 0.74 | 0.54 |
| Percent of variance | 3.10 | |

Visual analysis of the scree plot of eigenvalues shows that the first factor accounts for the most variance, followed by factor two; with minor factors sloping downward, indicating a one factor model (Cattell, 1966).

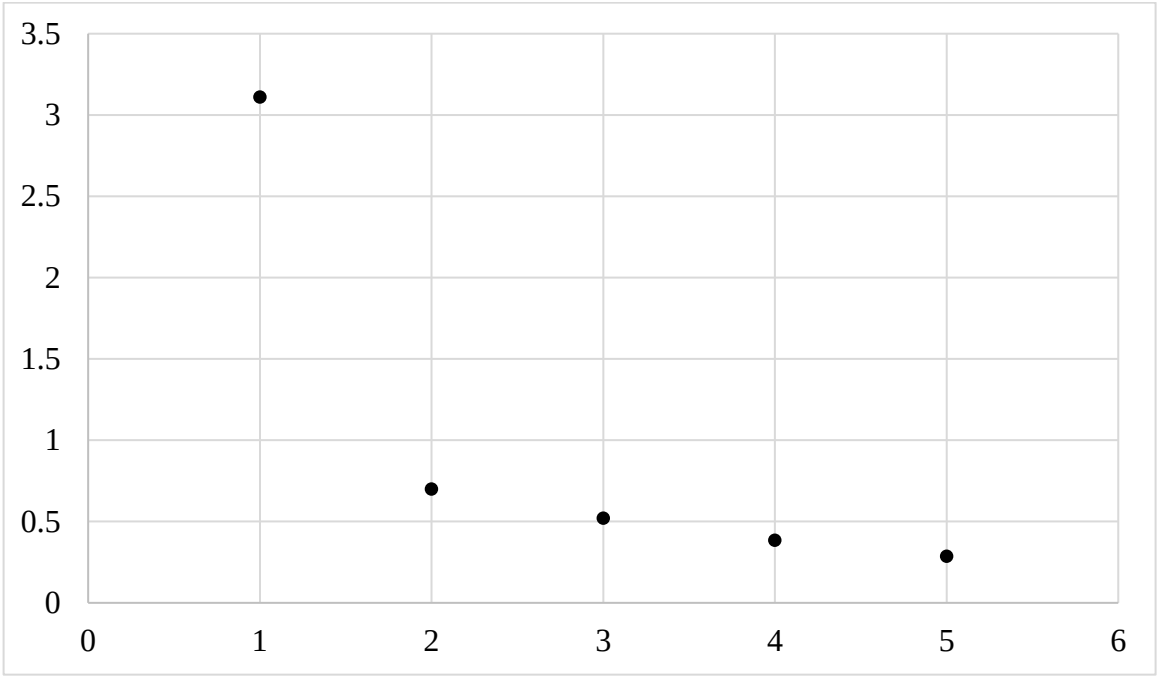


*Figure 9.* Scree plot of factors for gross motor scale (24-30 months)

Next, the interRAI 0-3 was evaluated for underlying constructs in gross motor. The 24 to 30-month age interval demonstrated a high level of internal consistency, with Cronbach's alpha reaching 0.893. Cronbach's alpha was used to determine that all items should be retained (Cronbach, 1951). Lastly, the full sample of all participants between 0-

47 months were broken into their relative age interval with a composite of associated items. Cronbach's Alpha for the full sample was questionable, with an overall score of .68.

*6.7 Inter-rater Reliability of the Gross Motor Domain Items*

To examine the reliability between rater 1 and rater 2 using all interRAI 0-3 gross motor domain items for 23 participants, a reliability analysis was conducted using continuous data. While using continuous data, Fleiss and Cohen recommend using the intraclass correlation, as it is comparable to weighted Kappa (1973). There was substantial agreement between the raters' indication of milestone achievement on the gross motor domain items according to the single measures intraclass correlation coefficient, ICC = .87, [95% CI, .72, .94], p< .001. The relationship between raters indicates significance in the consistency regardless of trained assessor.

*6.8 Criterion Validity of the Gross Motor Domain*

*6.8.1 Correlations with Criterion Measure*

Beginning with a correlational analysis of the ASQ-3 and interRAI 0-3 gross motor domains for children between 0-47 months, the continuous mean scores on both measures were associated. A Pearson's product-moment correlation demonstrated a strong positive correlation, $r(102) = .877$, $p < .001$, which indicated a positive relationship between performance on items on the interRAI 0-3 and ASQ-3 gross motor domain.

Subsequently, analysis of the nominal item, *M1. Family, Caregiver, Friend, or Staff Express Concern About Child's Gross Motor Skills* from the interRAI 0-3, and dichotomous pass-fail outcomes on the ASQ-3 and interRAI 0-3 gross motor domain was also found. Clinicians were asked to speak to close members of the child's family or

friends, examine clinical records if available, and observe the child. Manual instructions requested clinicians to endorse concern as either, *Yes* (i.e. 1), or *No* (i.e. "0"). To examine the relationship between endorsed concern and gross motor performance, a Pearson's product-moment correlation was run, indicating a strong negative correlation between the item *M1. Family, Caregiver, Friend, or Staff Express Concern About Child's Gross Motor Skills* and the ASQ-3 gross motor pass fail scores, $r(102) = -.71$, $p < 0.001$. Also, a moderate to strong negative correlation between the item M1 and the interRAI 0-3 gross motor scores was discovered, $r(638) = -.60$, $p < 0.001$.

*6.8.2 Bivariate Associations*

Initially, bivariate associations were calculated to examine the relationship between a dichotomous pass-fail variable comprised of children with or without musculoskeletal and neuromuscular problems including abnormal muscle tone or strength, orthopedic impairments, cerebral palsy, microcephaly, stroke and hypoxic ischemic encephalopathy (n = 138), and pass-fail outcomes on the interRAI 0-3 and ASQ-3. This item was found to have a positive and statistically significant relationship between dichotomous pass/fail items from the interRAI 0-3, $\chi^2(1) = 106.79$, $p < 0.001$, and ASQ-3 gross motor domain, $\chi^2(1) = 44.10$, $p < 0.001$. However, given that this is a binary variable and not an ordinal scale, the odds ratio is rather small. Children with musculoskeletal problems were slightly more likely to fail gross motor milestones on the interRAI 0-3 than the ASQ-3, with 80.2% of children with gross motor concerns failing outcomes on the interRAI 0-3, and 78.8% failing on the ASQ-3.

Table 16

*Bivariate association between musculoskeletal and neuromuscular conditions and pass-fail score on the ASQ-3 and interRAI 0-3 gross motor items*

| Variables | Musculoskeletal and Neuromuscular Problems | | Chi-square (sig.) |
|---|---|---|---|
| | Yes (%) | No (%) | |
| Achievement of interRAI 0-3 Gross Motor Domain | | | 106.79 (0.001) |
| Yes | 24 (19.8) | 335 (71.3) | |
| No | 97 (80.2) | 135 (28.7) | |
| Achievement of ASQ-3 Gross Motor Domain | | | 44.10 (0.001) |
| Yes | 11 (21.2) | 53 (82.8) | |
| No | 41(78.8) | 11 (17.2) | |

Next, following significant findings from the correlational analysis of the interRAI 0-3 and ASQ-3 gross motor domain, chi-square was calculated to further examine this relationship. In Table 17, 78.8% of participants did not achieve all performance-based items in the gross motor domain on the ASQ-3 and interRAI 0-3, and only 21.2% of participants did achieve the ASQ-3 gross motor items and did not succeed in the gross motor items from the interRAI 0-3. Conversely, 88% of participants achieved gross motor items from both instruments, with 12% achieving on the interRAI 0-3, but not on the ASQ-3. The association between performance of gross motor milestones on the ASQ-3 and interRAI 0-3 gross motor items was considered statistically significant, $\chi^2(1) = 45.84$, $p < 0.001$. The risk estimate for performing poorly on the interRAI 0-3 as compared to the ASQ-3 was 27.3.

Table 17

*Bivariate association between scores on ASQ-3 and interRAI 0-3 gross motor items (n = 102)*

| Variables | Achievement of ASQ-3 Gross Motor Domain | | Chi-square (sig.) |
|---|---|---|---|
| | Yes (%) | No (%) | |
| Achievement of interRAI 0-3 Gross Motor Domain | | | 45.84 (0.001) |
| Yes | 44 (88) | 6 (12) | |
| No | 11 (21.2) | 41 (78.8) | |

*6.8.3 Predicting Gross Motor Outcomes*

Although the ASQ-3 and interRAI 0-3 gross motor domains show overlap in achievement of milestones, binary logistic regression was used to ascertain the level of sensitivity and specificity provided by the model of prediction. The binary gross motor pass-fail outcomes from the ASQ-3 were used to predict the proportional scores on gross motor from the interRAI 0-3. All items within the respective age range pertaining to the child were used to generate a percentage of achievement. Results of the predictive model show that with an increase in achievement of gross motor milestones from the ASQ-3, the odds of achievement on the interRAI 0-3 increases by 6.2% (AOR = 1.062, 95% C.I. = 1.040-1.084). Hosmer-Lemeshow goodness of fit test results show strong model fit ($\chi^2$ = 1.203, df = 4, $p < .878$), and the Omnibus Tests of Model Coefficients found a chi-square value of 73.044, indicating statistical significance ($p < 0.001$). Nagelkerke R Square was used to find how well the model explained variance, indicating 69.1% was found. Sensitivity and specificity of the model was also calculated, with excellent findings of 89.6% and 84.6%, respectively. The risk estimate was also calculated for participants

with neuromuscular and musculoskeletal issues as compared to those without these physical conditions. Using dichotomous pass-fail items on the ASQ-3 and interRAI 0-3, the risk estimate was 10.02 on the interRAI 0-3, and 17.96 on the ASQ-3.

Table 18

*Logistic regression predicting outcome of achievement on interRAI 0-3 gross motor domain*

| Variables | β | OR | 95% C.I. | P value |
|---|---|---|---|---|
| Gross motor interRAI 0-3 achievement | 0.060 | 1.062 | 1.040-1.084 | **0.001** |

ROC curve analysis was used to generate the AUC, showing .914 (.854-.974) based on the percentage of achievement on the interRAI 0-3 by the ASQ-3 binary pass/fail outcomes

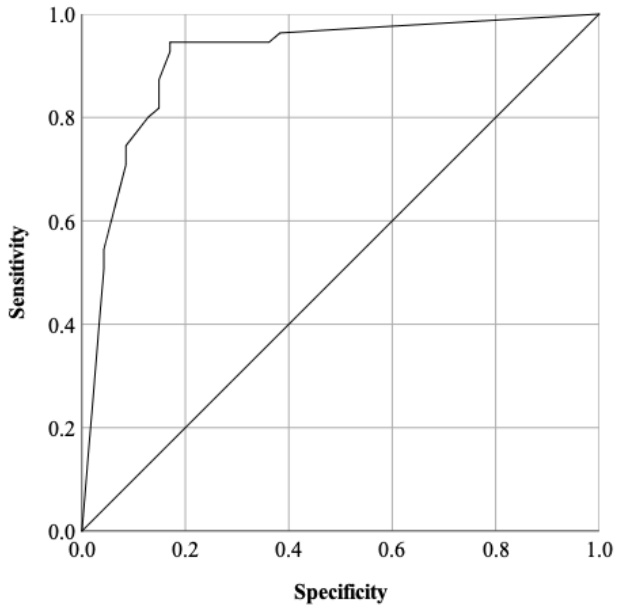

*Figure 10.* ROC Curve for ASQ-3 by interRAI 0-3 Gross Motor Domains

## 7.0 Discussion and Conclusion

The current study has outlined the preliminary reliability and validity of the interRAI 0-3 gross motor domain in order to address the study's research questions regarding inter-rater reliability, internal consistency and criterion validity. Given the integrated nature of the interRAI 0-3 with other interRAI child and youth assessments, promotion of using these tools to enhance current policy initiatives is also discussed, particularly for the early childhood period.

Initially, the data on gross motor functioning for children between 24-30 months was investigated for internal reliability. The internal consistency of the interRAI 0-3 was found using factor analysis with items in the age interval of 24-30 months. This age interval was selected for preliminary analysis given that this is a significant time for change, with gross motor ability drastically advancing. The initial correlations amongst items were significant, but did not indicate multicollinearity, suggesting that the items are not redundant. Interestingly, the first climbing item, *M2ii. Climbing – ascends or descends stairs with limited support, placing two feet on each step,* was more likely to be achieved in the 24-30 month age range, with the more challenging climbing item *M2.jj Climbing – ascends or descends stairs with limited support, alternating feet* was less likely to be achieved, which is possibly due to the wide age range and expectation for later achievement. Future work with the interRAI 0-3 gross motor items require further investigation for item difficulty and to examine all age intervals in order to calculate scales other than for the 24-30 month age range. Great variability in performance was expected, yet the factor structure retained the unique cluster of items and one factor was

held. Specifically, it was found that the percentage of variance predicted by the model surpassed communalities, and the items within the 24-30 month age intervals were internally consistent based on common variance. As in validation of other like scales, the latent structure of the model confirms clustering gross motor ability regardless of the type of movement, such as climbing, jumping or running (See Bricker & Squires, 2009), however fine motor skills were not included in this analysis. Cronbach's alpha was calculated for the 24-30 month age range and found to be 0.89, which is considered good (Cronbach, 1951). The factor structure is promising, however future reliability studies are needed to confirm the factor structure for each age interval now that preliminary work on the pilot has begun.

Consistency was also measured using inter-rater reliability of gross motor items for children between 0 and 47 months. The findings provided by the assessors indicated strong agreement based on the intraclass correlation coefficient for the 23 participants (ICC = .87). The interRAI 0-3 gross motor domain has demonstrated consistency amongst raters for a limited number of participants, thus further research can be done using a larger sample size. A recent review of motor assessments also indicates that for children suspected of having multiple impairments, assessment of gross motor development is best when combined with a full developmental assessment, given that more concerns are likely to be observed (Griffiths et al., 2018). The interRAI 0-3 gross motor section includes additional items not examined in the present study, which focus on lateral movement, range of motion and other motor functions. While not a goal of the present study, future work on test-retest reliability is needed in order to assess the consistency of participants' scores. One limitation of test development in childhood,

however, is that maturation is rapid in the early years, hence repeating assessments within a very short window of time is needed for reliability. Although several clinical assessments of motor function have not been assessed for their inter-rater reliability, such as the Bayley-III (Griffiths et al., 2018), the present analysis provides a preliminary measure of external reliability for interRAI 0-3.

In order to examine test validity, a number of correlations, bivariate associations and binary logistic regression were used. Initially, bivariate association between scores on the interRAI 0-3 and ASQ-3 gross motor domain items was obtained, showing 87.2% agreement for participants failing outcomes on both measures, with 80% agreement of achievement of outcomes. This indicates that children were highly likely to obtain "yes" or "no" to items on the ASQ-3 gross motor domain and items on the interRAI 0-3. While developing a concurrent measure, finding alignment in achievement is crucial for demonstrating concurrent validity (Boateng et al., 2018). Next, a Pearson product-moment correlation was explored for children between 0-47 months using the interRAI 0-3 and ASQ-3 gross motor domain total, which was converted into a percentage score. Correlational analysis revealed a strong relationship between participant scores on both instruments [$r$ (102) = .88, $p < .01$], suggesting that outcomes from the interRAI 0-3 are similar to scores on the ASQ-3 gross motor domain.

Subsequently, correlations were found between the interRAI 0-3 item, *M1. Family, Caregiver, Friend, or Staff Express Concern About Child's Gross Motor Skills* and pass-fail outcomes on the ASQ-3 and interRAI 0-3 gross motor areas. Correlations with the ASQ-3 [$r$ (102) = -.71, $p < 0.001$] were more strongly associated than with the interRAI 0-3 [$r$ (638) = -.60, $p < 0.001$], which indicates a need for improvement of the gross

motor domain. Further examination of the content of each instrument reveals that the number of items within age interval is similar. Increasing the number of items within each interval can lead to a more accurate understanding of the child's skills, however this may not be an argument for improving the interRAI 0-3 (Boateng et al., 2018). Inter-item correlations and factor analysis of each age interval on the interRAI 0-3 should instead be explored, in order to refine the number of items and ensure they remain a unique cluster well-suited to defining gross motor skills. The concern indicated by clinicians may have been focused on one portion of the body's gross motor functioning as well, whereas the items within each interval measure all aspects of gross motor development. An item that asks clinicians for concern regarding lateral portions of the body may be more relevant to specific items within the gross motor domain. For instance, a child may have full capability in their lower body, with reduced function of their upper limbs, thus a direct question about upper body functioning would be more relevant. Consistent with other research, evaluation of concern regarding milestones can be empirically validated and used to support decision making in primary clinical care environments that require rapid completion (See Brothers et al., 2008).

Finally, a relationship was explored between participants with musculoskeletal and neurological conditions and achievement of outcomes on the interRAI 0-3 and ASQ-3 criterion measure. Specifically, individuals indicated as having high-risk conditions affecting their motor development were likely to fail on the ASQ-3 (78.8%) and interRAI 0-3 (80.2%) gross motor domains, at a statistically significant level. This is compared to a typical sample of children without motor risk, of which 71.3% achieved milestones on the interRAI 0-3, and 82.8% achieved gross motor items on the ASQ-3. Although the typical

sample achieved slightly different rates of milestones amongst the tools, this validates that the interRAI 0-3 is similar to the criterion measure in determining poor outcomes for children with gross motor problems, and actually identified more children with neurological and musculoskeletal issues than the ASQ-3 in this regard. There is supporting literature that shows that neurological and musculoskeletal issues lead to problems with gross and fine motor milestone achievement (Goo et al, 2018; Krigger, 2006; de Graaf et al., 2011; Blank et al., 2012; Hadders-Algra, 2016). Orthopedic impairments are challenging and costly for families, and can lead to concerns regarding school achievement, cognition, language and behavioural outcomes, hence the need for appropriate assessment and intervention (Hofsten, 2009; Houwen et al., 2016; MacDonald et al., 2016; Leonard et al., 2014). Evaluation of the interRAI 0-3 gross motor domain using this at-risk group, helps to establish validity for a known group at risk of developmental delay or physical disability (Portney et al., 2006), however further research is needed to examine the sensitivity and specificity of a neuromuscular scale for at-risk children.

Finally, a predictive model of the interRAI 0-3 was evaluated using the pass/fail scores on the ASQ-3 criterion measure. Logistic regression revealed that achievement on the criterion measure predicts achievement on the interRAI 0-3, with high levels of sensitivity (89.6%) and specificity (84.6%). Recommendations for sensitivity and specificity vary according to population use, however sensitivity of 70% and specificity of 80% have been recommended for samples similar to this study (Glascoe et al., 2003). The gross motor domain falls above these recommendations, thus items should remain similar to their original form. Item development was done in stages, from review of the

literature and current assessments, to clinician and expert involvement as a process to ensure face validity. Refinement of items were based on extensive clinician feedback throughout the development process. This development phase undoubtedly supported validation efforts. Using the interRAI 0-3 gross motor domain as a means to assess for motor development is feasible for community providers looking for a valid means of detecting risk.

This study would be useful for clinicians and researchers looking to find a comprehensive instrument that captures the full scope of a child's ecological system, including gross motor development. The interRAI 0-3 instrument captures reliable and valid information which has clinical implications for developmental services in Ontario, Canada. Although important for test validation, the ability of one tool's outcomes to predict another is only important if this brings with it a more comprehensive and meaningful approach to assessment and intervention. Going beyond traditional measures, the interRAI 0-3 can systematically track the longitudinal data of children for the purpose of observing progress across the lifespan and detecting need for support. Agencies can utilize this data to in order to triage individual needs as well as evaluate service effectiveness. Allocation of resources can be better met, and collaborative action plans are generated to enhance clinician knowledge. The American Academy of Pediatrics (2010) and the Ontario Centre of Excellence for Child and Youth Mental Health (Kulkarni et al., 2019) developed policy recommendations and a task force to deal with the challenges of mental health and development, including a focus on coordination of care, documentation to enhance health care financing, referral and early identification, continuity of clinical information systems, and decision tools for clinicians, all of which

interRAI systems seamlessly integrate. Thus, from the perspective of early intervention, the interRAI 0-3 is a viable option for standardized care of children.

There is little doubt that the identification of young children with high risk of early motor impairment is crucial for reducing the later burden of this condition and providing children and families with timely access to early intervention services. As a prospective screener, the interRAI 0-3 gross motor items align well with the criterion measure and are predicted by criterion from ASQ-3 gross motor domain. The use of the interRAI 0-3 and all interRAI systems provide direct clinical benefits for children and youth and can assist in transforming health sectors and ultimately improving service system integration.

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# CHAPTER 4

## EXTENT OF PRETERM BIRTH AND RISK OF GROSS MOTOR DELAY

Jo Ann M. Iantosca

## 1.0 Background

Children who are born preterm (PT), or low birth weight (LBW) face additional barriers as compared to normal birth weight and full-term children, including risk of chronic developmental (i.e. motor, cognitive, communicative), behavioural, socio-emotional, and psychological difficulties. These children are also more likely to have a diagnosed neurodevelopmental or learning disability as compared to full-term children (Cheadle & Goosby, 2010; Shah et al., 2013; Fevang et al., 2016; Gladstone et al., 2015; Månsson & Stjernqvist, 2014; Johnson et al., 2016). When born LBW or PT, the neonate can be impacted by immediate medical complications such as respiratory distress or intraventricular hemorrhage, and future conditions of diabetes, heart disease and other health conditions (OECD, 2013). In concert, families undergo significant stress due to the additional challenges in financially, physically and emotionally supporting their child (Hodek, von der Schulenburg & Mittendorf, 2011; Gerstein & Poehlmann-Tynan, 2015; Cheadle & Goosby, 2010). Preterm birth and low birthweight also impact the longitudinal health and well-being of children and their families, making this an expansive population serviced by hospitals and other treatment facilities in Canada (Lim et al., 2009; Treyvaud et al., 2014).

Children born prior to 37 weeks' gestation are considered PT, and infants with a birthweight of under 5.5 pounds are identified as LBW regardless of gestational age (OECD, 2013; Howson et al., 2012). Although infant mortality has decreased in many developed countries, the incidence of children born with low birth weight is increasing, with estimates in Canada at 6.3 percent, and late preterm births rising 20% from 1990 to 2006 in the United States (OECD, 2013; National Center for Health Statistics, 2009).

Increasingly, more attention has been given to children born late preterm, between the gestational age of 34 to 36 weeks of pregnancy, due to recently observed disparities in health and developmental outcomes (Raju, 2006; National Center for Health Statistics, 2009; Woythaler, McCormick & Smith, 2011; Johnson et al., 2015), however, extremely low birthweight (ELBW) or very preterm (VPT) children are still at greatest risk (Cheadle & Goosby, 2010; Fevang et al., 2016; Gladstone et al., 2015; Mikkola et al., 2005). Internationally, the prevalence of preterm births falls around 10-11 percent, with LBW and PT more common in developing countries (Blencowe et al., 2012; Beck, et al., 2010).

Preventable conditions such as poor maternal mental and physical health, maternal smoking or use of toxic substances, mothers' age at birth, and inadequate prenatal care provide some explanation for the cause of this condition (Bouras et al., 2015; Bandstra et al., 2010; Finnegan, 2013; Howson, 2012). A common maternal health complication is gestational diabetes during pregnancy. Type 2 diabetes as diagnosed at or before 26 weeks' gestation was found to be a leading risk for the later diagnosis of Autism Spectrum Disorder (ASD), while controlling for several other common predictors such as maternal smoking, body mass index and socio-economic status (Xiang et al., 2015). Maternal age during pregnancy has also been found to predict low birth weight and preterm birth, in addition to elective caesarian surgery, and post-health outcomes for the mother (Oakley et al., 2016). Prenatal exposure to substances such as illicit drugs and alcohol, are responsible for health and developmental problems in childhood and adolescence and can lead to increased likelihood of preterm birth (Bandstra et al., 2010; Finnegan, 2013; O'Keeffe et al., 2014). Finally, maternal stress in utero is linked to low birth weight or preterm birth, however this

evidence has not been conclusive when examining stress hormones (Nkansah et al., 2010; Kramer et al., 2013; Romero-Gonzalez et al., 2018).

Non-maternal characteristics of preterm birth include being a product of multiple birth, and time spent in a neonatal intensive care unit (NICU). Many preterm or low birth weight children are likely to have spent time in a NICU, impacting the development of sensory systems and ultimately affecting later outcomes in language, cognition and motor areas (Subedi et al., 2017; Vandormael, et al., 2019). In one study, preterm children were assessed at multiple time points from 9 months of age into kindergarten, and authors found that the extent of preterm birth as measured by gestational age no longer predicted child outcomes, but rather, the increased length of stay in NICU predicted milestone achievement more substantially (Subedi et al., 2017). Due to any number of maternal and non-maternal issues, children born preterm or low birth weight have broad deficits impacting their development.

*1.1 Developmental Patterns of Preterm and Low Birth Weight Children*

Researchers have been examining the continued effects of PT and LBW, including a number of health and developmental issues that are present prior to and beyond kindergarten. Major areas of research revolve around the social competence and behavioural presentation of children born PT or LBW, as well as their cognitive development and academic performance in later life.

Children born PT and LBW display greater dysfunctional behaviour, reduced social competence, and a wide range of psychosocial concerns as compared to their full term and normal-birth-weight peers (Fevang et al., 2016; Jones et al., 2013). In a meta-analysis of recent literature, authors found that young children born with severe levels of PT or LBW

struggled with poor emotional regulation, social skills, and had more attentional problems as compared to full term children, which predicted future dysfunctional behaviour into school age, regardless of cognitive performance (Arpi & Ferrari, 2013). LBW and preterm birth also lead to high levels of maternal stress and burdens child-parent interactions, potentially impacting the behavioural outcomes of these children (Gerstein & Poehlmann-Tynan, 2015; Gerstein et al., 2017; Fevang et al., 2015; Poulsen et al., 2013; Ritter et al., 2013; Woythaler et al., 2011; Yates et al., 2010). Executive functioning is significantly correlated with childhood social competence, with impairments in executive function prevalent amongst PT and LBW children, particularly childhood inhibitory control (Alduncin, 2014; Jones et al., 2013; Ritter, 2013).

Children with severe low birth weight and very preterm birth who demonstrate an early delay in executive functioning, may also display cognitive impairment beyond adolescence and into adulthood (Ritter, 2013; Eryigit Madzwamuse et al., 2015). It has also been observed that late and moderately preterm children demonstrate significant delays in cognitive function as well (Johnson et al., 2015). In the early years, low birth weight and preterm children demonstrate significantly lower motor, communication and cognitive skills as compared to full-term children (Mansson & Stejernqvist, 2014; Peyton et al., 2018). Even the early abilities of infants to use gestures and other forms of receptive language is affected by these vulnerabilities, which tends to create conditions for future identification of learning disabilities in the school setting (Stolt et al., 2016; Johnson et al., 2016; Barre et al., 2011). Likewise, childhood motor development, often seen as partly responsible for early cognitive function, is negatively impacted by pre-term birth or low birth weight, regardless of diagnosis of physical disability (Sansavini et al., 2014; Van Hus,

et al., 2013). It is this coordinated process of tuning the gross and fine motor systems that prepares children for more complex tasks in later childhood. Motor skills are crucial in determining independence of children on such tasks as dressing, feeding, hygiene-related activities, as well as on oral and written academic tasks in school settings (Houwen et al., 2016; MacDonald et al., 2016). Children across all levels of severity are at risk for achieving lower IQ scores, more likely to receive placement in special education, as well as decreased academic scores across reading, writing and mathematics as compared to normal-birthweight children (Basten, et al., 2015; Poulsen at al., 2013). Even while controlling for the effects of family socio-economic status, for instance, the poor educational performance of preterm children can lead to future decreases in educational attainment later in life, and similarly, less well-paying positions of employment (Basten et al., 2015).

The early intervention literature pertaining to preterm and low birth weight children is scarce and often immaterial (See Johnson, 2009; Evans et al., 2017), however, the early effects of LBW and PT birth on infant and toddler development should be explored in order to enhance early intervention efforts. In one of the first intervention studies to demonstrate significant results across developmental domains in this population, authors used a *family nurture intervention* to improve attachment in the neonatal intensive care unit (NICU), which led to improvements in the infants' cognitive and language scores, as well as increasing social-relatedness and decreasing attention problems (Welch et al., 2015). Interventions in this vulnerable group must consider the child's neurodevelopmental disability, the context of the intervention, as well as confounding factors such as demographic or individual characteristics.

With early intervention, it is also crucial to use strong measures of infant and toddler development that pertain to the unique needs of low birthweight and preterm children across specific developmental domains. Few recent studies have evaluated currently used infant and toddler assessments of developmental milestones (See Greene et al., 2012; Lefebvre et al., 2016; Sansavini et al., 2014; Agarwal et al., 2016, 2017). Commonly administered instruments have also been criticized for inaccurate cut offs amongst very preterm or low birth weight children, as well as unexplained variance in predicting future motor function and classification instability over time (See Duncan et al., 2015; Luttikhuizen et al., 2013; Lobo et al., 2014). In a recent meta-analysis investigating the predictive capacity of future cognitive outcomes for preterm and low birth weight children, common early childhood assessments such as the Bayley Scales of Infant Development, had greater specificity overall, but sensitivity was typically lower when examining future outcomes (Wong et al., 2016). Wong and colleagues (2016) recommended that test developers examine more closely the predictive accuracy of their screens, and link to consistent follow up assessment in order to increase the odds of detecting later delay. However, others have discovered findings that are strongly predictive of determining developmental delay amongst preterm and low birth weight infants (Agarwal et al., 2016, 2017). The accuracy of tests is also important to help determine resource allocation. The resources needed to service this population in Canada ranges based on birthweight and preterm birth, with the cost growing substantially higher than for children born full term and normal birthweight (Lim et al., 2009). For instance, those who are born in the range of 1,000 to 1499 grams, cost an average of $50,000 as newborns, and for those born preterm at any gestational age, costing $9,233 and up to $84,235 when extremely preterm (Lim et

al., 2009). Thus, for the purposes of early intervention, it is crucial to determine the immediate consequences of preterm and low birth weight newborns by evaluating commonly administered screening and assessment tools for this population.

interRAI is a non-profit conglomerate of researchers from around the world, who develop assessment systems to target the needs of individuals across the lifespan. The child and youth suite of assessments includes the interRAI 0-3, which has been developed to identify the overall developmental needs of children between 0-47 months of age, as well as their family. The interRAI 0-3 captures more than 650 items that seek insight on ecological risk factors, family dynamics, medical and mental health information, as well as all areas of early development. This newly established instrument, however, has yet to explore the development of preterm children under the age of four in the motor domain. In the present study, data from the interRAI 0-3 validation study will be used to explore the motor findings of children at risk due to issues such as preterm birth, or low birthweight. This study used data from the interRAI 0-3 to investigate the following research questions, *What prenatal and perinatal risk factors are associated with poor gross motor outcomes for children between 6-47 months of age?* And, *How do children between 6-47 months perform on gross motor outcomes based on extent of prematurity?*

**2.0 Procedure**

Participants for the bivariate analysis of prenatal and perinatal factors included a sample of 591 children between the ages of 6 to 47 months of age, with 24.2% (n = 143) which have been identified as preterm (<37 weeks). The same sample was used to measure the extent of prematurity and gross motor outcomes. Children were recruited from developmental or mental health services in Ontario, Canada.

Assessors using the interRAI 0-3, included clinicians from the respective agencies. Assessors were provided a 2-day training on the interRAI 0-3 prior to data collection. Each interRAI 0-3 assessment took approximately one hour to complete depending on case complexity. Clinicians used multiple sources of information to complete the interRAI 0-3, including observation of the child, parent/guardian interview, and other clinical data such as case files. Reviewing and integrating information from collateral reports prior to completing the assessment usually results in more efficient use of time when interviewing caregivers and children. The area of focus for this study included only the gross motor domain, however data from the full interRAI 0-3 assessment was collected for a larger validation study.

**3.0 Plan of Analysis**

The current study initially sought to examine the correlations between risk items (i.e. premature birth, low birthweight, neonatal intensive care, maternal nicotine and alcohol use, and maternal health problems) and performance on gross motor milestones as a means to discover convergence between risk items and associations with gross motor performance. Next, bivariate associations were used to discover the successful and failed performance of *at risk* and *no risk* children on the interRAI 0-3 gross motor domain. Initially, contingency tables and chi square were calculated for predictors of developmental outcomes for premature children based on the literature. Proposed variables that contribute to poor developmental outcomes included maternal age, premature birth, birthweight, maternal health problems, stay in NICU, as well as maternal nicotine and alcohol use. Though important to this research, variables not included in the analysis were *assistive*

*reproductive technology used to achieve pregnancy*, and *child is a product of multiple birth*, as this subsample of participants was not substantive.

Finally, an independent-samples Kruskal-Wallis test was conducted to examine the gross motor outcomes of children born extremely preterm (at or below 28 weeks' gestation), very preterm (at or below 32 weeks' gestation), moderate to late preterm (39 to 33 weeks' gestation) and at 40 weeks' gestation or having no reported preterm birth. A non-parametric test was chosen as a test of normality revealed that homogeneity of variances could not be assumed. Box-plots were used to determine differences in scores across levels of prematurity, a means test was carried out and post hoc tests were used to determine levels of significance among gross motor scores between categories.

## 4.0 Results

### *4.1 Demographics*

The present study used a sample of 591 participants between the ages of 6-47 months from the interRAI 0-3 pilot study data base (M = 31.6, SD = 12.71). The characteristics of the sample include a majority of male participants (62.4%), with 37.5% of female participants (See Table 19). Many children were identified as preterm, with a gestational age under 37 weeks (20.3%) with the majority considered moderate to late preterm, and only 11.2% of the sample was considered low birthweight. Much of the sample had been placed in some level of neonatal care after birth (43.1%), and 28.3% of mothers had health complications during the pregnancy or delivery. The most common health complications included gestational diabetes, hypertensive disorders and fetal distress.

Table 19

*Characteristics of interRAI 0-3 participants 6-47 months (n = 591)*

| Variables | Frequency (%) | Mean | *SD* |
|---|---|---|---|
| Age at assessment | | 31.6 | 12.7 |
| Sex | | | |
| Male | 369 (62.4) | | |
| Female | 222 (37.5) | | |
| Preterm birth | | | |
| Yes | 120 (20.3) | | |
| No | 471 (79.7) | | |
| Levels of prematurity | | | |
| Extremely preterm | 16 (2.7) | | |
| Very preterm | 37 (6.3) | | |
| Moderate/late preterm | 91 (16.4) | | |
| 40 weeks' gestation | 447 (75.6) | | |
| Low birth weight | | | |
| Yes | 61 (11.2) | | |
| No | 482 (88.8) | | |
| Neonatal intensive care | | | |
| Yes | 222 (43.1) | | |
| No | 293 (56.9) | | |
| Maternal health problems during pregnancy or delivery | | | |
| Yes | 142 (28.3) | | |
| No | 360 (71.7) | | |
| Maternal nicotine use during pregnancy | | | |
| Yes | 83 (16) | | |
| No | 437 (84) | | |
| Maternal alcohol use during pregnancy | | | |
| Yes | 27 (4.6) | | |
| No | 531 (89.8) | | |

*4.2 Correlational Analysis of Risk and Gross Motor Milestones*

Initially, Pearson-product moment correlations were run to seek evidence between performance on gross motor items and variables that place children at risk of poor performance. Items from the interRAI 0-3 that were used included preterm birth and low birthweight, stay in a neonatal intensive care unit, maternal health problems during

pregnancy and maternal nicotine use during pregnancy. Interestingly, the findings showed significant negative correlations between performance on gross motor and all risk-oriented items except for nicotine use during pregnancy, however the strength of relationship between other items was weak. While the direction of the relationship is not clear, either an improvement in performance on gross motor leads to decreased risk, or an increase in risk leads to poor performance on gross motor items. Correlations between risk-items were also sought, indicating convergence between constructs that are commonly known to load together. Children with any known risk, such as preterm birth, was found to relate to other risk factors such as receipt of neonatal intensive care.

Table 20.

*Correlation matrix between gross motor performance and risk factors for development*

| Items | | Low birthweight | Stay in neonatal intensive care unit | Maternal health problems during pregnancy | Maternal nicotine use during pregnancy | Maternal alcohol use during pregnancy | Gross motor performance (pass/fail) |
|---|---|---|---|---|---|---|---|
| Preterm birth | Pearson Correlation | .389** | .496** | .283** | .013 | -.025 | -.154** |
| | Significance (2-tailed) | .000 | .000 | .000 | .766 | .562 | .000 |
| | N | 591 | 561 | 545 | 564 | 558 | 591 |
| Low birthweight | Pearson Correlation | | .300** | .096* | -.042 | .060 | -.110* |
| | Significance (2-tailed) | | .000 | .029 | .339 | .169 | .000 |
| | N | | 528 | 516 | 533 | 528 | 543 |
| Stay in neonatal intensive care unit | Pearson Correlation | | | .235** | .031 | .032 | -.200** |
| | Significance (2-tailed) | | | .000 | .483 | .466 | .000 |

| | | | | | |
|---|---|---|---|---|---|
| | N | 510 | 525 | 521 | 515 |
| Maternal health problems during pregnancy or delivery | Pearson Correlation | | -.021 | .004 | -.108* |
| | Significance (2-tailed) | | .635 | .935 | .000 |
| | N | | 521 | 521 | 502 |
| Maternal nicotine use during pregnancy | Pearson Correlation | | | .296** | .043 |
| | Significance (2-tailed) | | | .000 | .331 |
| | N | | | 548 | 520 |
| Maternal alcohol use during pregnancy | Pearson Correlation | | | | .135** |
| | Significance (2-tailed) | | | | .002 |
| | N | | | | 514 |

**Correlation is significant at the 0.01 level (2-tailed)

*Correlation is significant at the 0.05 level (2-tailed)

*4.3 Bivariate Associations of Risk and Gross Motor Outcomes*

Using items from the interRAI 0-3, common predictive risk factors were chosen to explore associations with developmental outcomes on the gross motor domain as a stronger measure of relationships between variables (See Table 21). The findings suggest that children with no identified risks were more likely to achieve gross motor milestones at a higher rate than those with identified risk factors, however there was less variability in achievement found within the at-risk group. The gross motor findings indicated that within the at-risk group, most children identified as being preterm, low birthweight or having other risks for developmental delay were found to succeed or fail milestones nearly equally. The risk estimates for each variable, however, show that passing as compared to failing gross motor milestones for preterm birth, low birthweight, maternal health issues during pregnancy, or being in neonatal intensive care does not increase the

risk estimate to above 1. Conversely, maternal nicotine use (1.27), and alcohol use during pregnancy (5.51) did lead to an increased risk estimate, with the group that failed gross motor milestones (1.16; 3.62) respectively, showing a risk estimate above 1.

Table 21

*Bivariate association between achievement of gross motor milestones and predictors for children 6-47 months (n = 591)*

| Variables | Achievement of Gross Motor Milestones | | Chi-square (sig.) |
|---|---|---|---|
| | Yes | No | |
| Preterm (<37 weeks) | | | **.000 (0.001)** |
| Yes | 55 (45.8) | 65 (54.2) | |
| No | 304 (64.5) | 167 (35.5) | |
| Low birth weight (<1500grams) | | | |
| Yes | 28 (45.9) | 33 (54.1) | **.011 (0.001)** |
| No | 303 (62.9) | 179 (37.1) | |
| Neonatal intensive care | | | **.000 (0.001)** |
| Yes | 110 (49.5) | 112 (50.5) | |
| No | 203 (69.3) | 90 (30.7) | |
| Maternal health problems during pregnancy or delivery | | | **.015 (0.001)** |
| Yes | 72 (50.7) | 70 (49.3) | |
| No | 225 (62.5) | 135 (37.5) | |
| Maternal nicotine use during pregnancy | | | .330 |
| Yes | 53 (63.9) | 30 (36.1) | |
| No | 254 (58.1) | 183 (41.9) | |
| Maternal alcohol use during pregnancy | | | **.002 (0.001)** |

| | | |
|---|---|---|
| Yes | 23 (88.5) | 3 (11.6) |
| No | (284 58.2) | 204 41.8) |

*4.4 Mean Differences in Gross Motor Performance Based on Extent of Preterm Birth*

Initially, the number of weeks a child was born prematurely was converted into categories of extremely premature, very premature, moderate to late premature and 40 weeks' gestation. These variables were then examined for normal distribution according to the Shapiro-Wilk's test of normality. The results indicate that although the very preterm category was considered normally distributed, all other levels of prematurity did not meet the normality assumption. Given the low and unequal sample sizes within each category, a non-parametric test was selected in order to reduce type I error (Kruskal & Wallis, 1952). An independent-samples Kuskal-Wallis Test was used, and initial examination of the boxplot indicated that distributions of gross motor scores were different for each level of premature birth. The distributions of gross motor scores were significantly different across categories of prematurity $H(3) = 15.520$, $p = .001$, thus the null hypothesis was rejected. Gross motor scores decreased from 40 weeks' gestation (mean rank = 310.77), to moderate to late preterm (mean rank = 258.96), and to very preterm (mean rank = 234.54), however extremely preterm (mean rank = 236.28) performed comparably to very preterm.

Given the level of significance, pairwise comparisons using Bonferroni correction were executed. Accepting statistical significance based on adjusted p-values at the $p < .05$ level revealed differences between gross motor scores for two categories. Post hoc analysis showed statistical significance between gross motor scores for very preterm birth

and 40 weeks' gestation ($p$ = .04), and between moderate to late preterm and 40 weeks' gestation ($p$ = .04), but not between other groups.

## 5.0 Discussion and Conclusion

The present study examined relationships between perinatal and prenatal risk for gross motor delay, including preterm birth and low birthweight, stay in NICU, maternal health problems as well as nicotine and alcohol use during pregnancy. Associations between these variables is discussed in relation to the following research question, *What prenatal and perinatal risk factors are associated with poor gross motor outcomes for children between 6-47 months of age?* Next, the mean gross motor scores of children were compared based on levels of preterm birth in order to answer the subsequent research question, *How do children between 6-47 months perform on gross motor outcomes based on extent of prematurity?*

Initially, a correlation matrix was generated to examine the relationship between risk-items on the interRAI 0-3 and their association with pass/fail performance of gross motor milestones. The results indicated that items such as preterm birth and low birthweight, time in a neonatal intensive care unit, and maternal health problems during pregnancy or delivery are all positively and significantly correlated with one another, however maternal nicotine and alcohol use were not correlated with these other risk factors, rather correlated with one another. An increase in any one of the correlated risk factors indicate that the others will also linearly increase. This is an important finding, as it shows that multiple interRAI 0-3 items that link to preterm birth show convergence, however, this also increases the likelihood of multicollinearity in any logistic model going forward. Additionally, these items all show a negative relationship with pass/fail

outcomes from the gross motor domain, which is a common finding in the literature for preterm children. Conversely, alcohol use during pregnancy showed a positive statistically significant relationship, which is likely due to limited sample size ($n$ = 26). Additionally, the relationship between poor performance on gross motor outcomes was expected to be stronger for the at-risk population given the literature which shows that prenatal and perinatal factors have significant influence over gross motor achievement (Ghassabian et al., 2016; Yaari et al., 2018). The present study found that the strength of correlations with gross motor outcomes ranged between -.108 for maternal health problems during pregnancy and -.200 for stay in a NICU. Finally, the risk estimate seemed to be highest for variables pertaining to alcohol and nicotine use, more than other perinatal and prenatal factors.

Of the risk factors discussed in this study, of particular interest was the necessity of neonatal intensive care. Much of the current literature shows that children born preterm require care by specialists in a NICU, and that a longer period of time spent in this type of care forecasts poorer developmental outcomes (Subedi et al., 2017). Staying in a NICU is also hypothesized to impact the infant beyond the effects of their prematurity or low birthweight by having increased medical interventions and reducing holding behaviour (Pineda et al., 2018). An increase in holding the child leads to stronger tuning of the reflexes based on parent interventions (Pineda et al., 2018). There is evidence to suggest that neuromuscular development can be delayed due to length of stay in a NICU, thus future research should further investigate this relationship using data from the interRAI 0-3 (Zuccarini et al., 2016).

The interRAI 0-3 adjusts for prematurity within all developmental domains for children under 24 months, which also may be responsible for the weak correlation with gross motor performance. Several assessments that measure child development correct for age by subtracting the number of weeks premature, by the child's chronological age (See Bricker & Squires, 2009; Bayley, 2006). We employed the same process to ensure that we capture accurately, the gross motor development of preterm children, as they are still biologically maturing. However, this has been criticized for underserving populations of children still considered at-risk for delay, noting that intervention services may be offered to less children who could still benefit from access (Yaari et al., 2018). Thus, it has been recommended that chronological and corrected age be considered for intervention purposes (Yaari et al., 2018). Future research using the interRAI 0-3 should examine participants scores within their age range without correcting for prematurity to find any measurable differences.

Bivariate associations with risk factors including preterm birth, low birthweight, time spent in a neonatal intensive care unit and maternal health problems during pregnancy were also analyzed in order to generate chi-square. These risk factors were found to be associated with higher risk of failure on gross motor domain items from the interRAI 0-3 by comparing at-risk children to the rest of the study population. For instance, 45.8% of children born preterm (< 37 weeks' gestation), achieved motor outcomes as compared to 64.5% of children who were not born preterm. Similarly, children born with low birthweight achieved gross motor outcomes 45.9% of the time, with 62.9% of full-term children achieving milestones for their corrected age. This further reflects findings in the literature that suggest children who are considered preterm

or low birthweight function below full term peers on motor outcomes (Sansavini et al., 2014; Lean et al., 2018; Yaari et al., 2018).

Within the group of preterm children in this study, more participants were likely to fail motor milestones. Specifically, of the children born preterm, 45.8% were able to achieve gross motor milestones, and 54.2% did not, and nearly identical findings for were discovered for the passing (45.9%) and failing (54.1%) low birthweight group. Yet, the variability amongst the full-term cohort was wider, with 64.5% of children achieving gross motor milestones for their age, and only 35.5% failing such milestones. Studies have found poorer results in very preterm and low birthweight children across all developmental domains (Lean et al., 2018; Yaari et al., 2018), thus future research should investigate associations between prenatal and perinatal risk factors using extent of preterm birth, as the differing levels of prematurity may reflect more variability based on at-risk outcomes. Finally, it may be that for children born pre-term, more immediate intervention services were given, leading to an indiscriminate difference between the participants who achieved or did not achieve particular milestones.

Lastly, the Kruskal-Wallis test was used to determine the mean difference in gross motor scores for children considered 40 weeks' gestation, moderate to late preterm, very preterm and extremely preterm. Distributions amongst the groups varied at a statistically significant level, $H(3) = 15.520$, $p = .001$, indicating that level of preterm birth effects the gross motor abilities of children, based on corrected age. The mean rank of 40 weeks' gestation was highest, then moderate to late preterm, and very preterm, however extremely preterm children performed slightly better, but not statistically superior than the very preterm category. Research suggests that the most at-risk groups (i.e. very

preterm) tend to do most poorly on functional assessments, finding a reduced effect with children who are less severe (Schonhaut et al., 2013). It is posited that the small number of participants in the extremely preterm group (n = 16) were not sufficient to capture changes in the distribution. The only groups that were statistically significantly different in their achievement of gross motor milestones were the moderate to late preterm and the very preterm groups as compared to children considered 40 week's gestation.

It must also be considered that moderate to late preterm group could be parsed out into early term and late preterm, however criteria based on the World Health Organization (WHO, 2018) was followed in order to support sample size. Even with following the categories provided by WHO (2018), the sample size of each group should be considered a limitation to interpretation of these findings. With an increased sample size, it would be interesting to examine preterm gross motor scores in infants as compared to older children in our sample, as there are early neuromuscular differences which lead to poor object manipulation at 6 months, and later motor difficulties in children at the age of two years (Zuccarini et al., 2016; Allotey et al., 2018).

The present study findings confirm that very preterm children perform poorly on gross motor outcomes as compared to full-term children, however that late and moderate preterm birth are still suggestive of concern. Recent studies have been done to explore late preterm children, noticing significant differences in achievement across a broad range of milestones both early in childhood and later into school-age (Raju, 2006; National Center for Health Statistics, 2009; Woythaler, McCormick & Smith, 2011; Johnson et al., 2015). The findings from this study reflect much of what is found in the literature and confirm the presence of concern for this population using data collected

from interRAI 0-3. This helps to substantiate the use of the interRAI 0-3 as an instrument that accounts for levels of prematurity and prenatal and perinatal risk. Further research should explore predictive models based on maternal and post-term risk in order to replicate past studies and confirm the use of the interRAI 0-3 as predicting poorer developmental outcomes for this population. Future work should also consist of measuring the impact of preterm birth on different age cohorts in order to explore the longitudinal effects on gross motor development. Preterm birth and skill development in domains such as language, executive function and social-emotional areas should also be explored in order to replicate findings on preterm performance.

Children also mature rapidly and using a full cohort of children between 6 to 47 months may have led to increased variability of the sample. It would be interesting to explore different age groupings to see what is predictive for individual age ranges. This has been done in other research to counter the issue of developmental variability, and more closely examine psychometric properties that appear to improve with the age at assessment (Schonhaut et al., 2013). The study population used for analysis also amalgamated new intake cases and those that may have been in a clinical program receiving early intervention. These cases could not be separated because this pilot study was the first of its kind to evaluate the interRAI 0-3, thus all cases in the database were considered an initial assessment. Future work will have the capability to separate first assessment from routine or discharge assessments. Finally, children who were considered preterm or low birthweight may have experienced other medical comorbidities or multiple diagnoses that impacted the association with these items. With increased data

collection efforts, supplementary research into the role that comorbid diagnoses have on the preterm or low birthweight population could expand the impact of the interRAI 0-3.

Children who are preterm and low birthweight have been found to exhibit more delayed developmental trajectories than child who are born full-term and normal birthweight. With the incidence of low birth weight and late preterm birth rising, increased emphasis should be placed on investigating this vulnerable population. The interRAI 0-3 was examined for associations between risk factors for delay and levels of preterm birth on gross motor outcomes, which was an integral part of test development efforts.

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# CHAPTER 5

DISCUSSION AND CONCLUSION

Jo Ann M. Iantosca

## 1.0 Discussion and Conclusion

Guided by the dynamic perspective of ecological systems theory, the aim of this research was to discuss the construction of the interRAI 0-3 as a comprehensive measure of child development, health and well-being, and further evaluate the reliability and validity of the instrument across the gross motor and language domains. The final intentions of this thesis were to focus on predictors of gross motor outcomes using associated perinatal and prenatal risks, with attention given to levels of preterm birth. This is the first study of its kind to explain the development and evaluation the interRAI 0-3 developmental areas, and it makes a large contribution toward validation efforts. The interRAI 0-3 is beginning to have uptake as a standard of care instrument across child health agencies in Ontario, Canada, thus validation efforts will help to establish much needed psychometric properties. The preliminary validation of the interRAI 0-3 will help to better inform clinical practice and intervention at the earliest possible age.

### *1.1 Contributions of the Individual Papers*

The introductory chapter outlines a number of policy and clinical implications for the use of current assessments. Existing assessments tend to observe the child's developmental outcomes as separated from their ecological setting, which generates poor knowledge of the reason for their outcome. For instance, a child's development can be impacted by genetic predisposition, parental nurturance, encouragement, child temperament and caregiver stability (Mash & Barkley, 2014; Shonkoff & Meisels, 2000; Laukkanen, 2014; Kiernan and Huerta, 2008; Goodman et al., 2011; Verhulst et al., 2011; Leerkes et al., 2015; Jaffee et al., 2007; Rijlaarsdam et al., 2013). These are not frequently measured in concert with developmental outcomes for children on existing

tools. Additionally, the outcomes that are generated by typical screening tools and assessments of child development do not produce protocols for intervention that can be applied across many clinical settings. Clinical cut offs are insufficient alone in determining targeted care plans for young children. Finally, most instruments are not constructed to track the longitudinal changes of children as they make transitions in their use of services (Kulkarni et al., 2019; Center on the Developing Child from Harvard University, 2016). The interRAI suite of assessments provides a sequence of understanding as the child matures. Instruments can be used across all settings, with training on use with certain populations. This makes the construction of the interRAI 0-3 a prominent change to the framework of assessment and early intervention. The introductory chapter also sets a clear picture of the construction efforts that led to the development of this pilot study. The construction of each section of the instrument was carefully designed using recommendations by clinicians, test-developers, and by reviewing empirical literature and other assessments. To begin preliminary validation of the instrument, Paper 1 (chapter 2) focusses on items related to expressive and receptive language as a measure of child development.

Impairment in speech or language development can impede on future school related tasks as well as childhood behaviour and has been found to have high prevalence in many countries around the world (McLeod & Harrison, 2009). Paper 1 utilizes a criterion measure, the ASQ-3 communication domain, to evaluate a relationship to the interRAI 0-3 language domain for all age intervals between 0-47 months, and to determine how well pass/fail data from the ASQ-3 predicts the interRAI 0-3 outcomes. Two important findings were the strong positive association between the instruments, and the ability of ASQ-3 to

strongly predict outcomes on the interRAI 0-3. This paper also outlined the reliability of two age-related scales for children between 20-24 and 24-28 months of age, finding strong internal consistency using exploratory factor analysis, though other age intervals still need to be explored and confirmatory factor analysis should also be used going forward using non-pilot data. The last major contribution to this paper was the strong relationship between two raters using items from the language domain. There was evidence of strong agreement found, indicating that there is stability amongst assessors. These methods have been well documented in educational and psychological testing and have been used in empirical research on the evaluation of commonly used child and youth assessments (See Stewart, Theall, et al., in press; Stewart, Theall, Fry et al., in press; Phillips, Hawes, et al., 2015). Building on Paper 1, Paper 2 approaches validation and reliability analysis of the gross motor domain in a similar fashion.

Paper 2 seeks to find similar associations between the ASQ-3 and interRAI 0-3 using the gross motor domain, as well as predict outcomes using the ASQ-3 as the benchmark. Interestingly, Paper 2 finds stronger associations and a more predictive model using gross motor data as compared to the language domain. This may be due to the more observable data needed for documenting motor milestones, or its more measurable latent construct as separated from fine motor tasks. Scale reliability was also sought for the 24-30 month age interval, demonstrating robust internal consistency, and interrater reliability showed evidence of strong agreement between raters. One unique contribution to this paper was the relationship found between childhood physical or neurological disability and poor gross motor outcomes. This aided in validating gross motor domain items for known groups, given the observed disparities of children with poor motor development (Goo et al., 2018).

Finally, Paper 3 builds on the gross motor validation efforts by investigating associations of poor performance using preterm birth, low birthweight, maternal health problems during pregnancy or delivery and hospitalization in a neonatal intensive care unit. Paper 3 initially provides evidence of correlations amongst predictors of poor development in the gross motor domain, revealing that multiple items on the interRAI 0-3 are related, but also illuminates the linear relationship between known risks and gross motor outcomes. Associations are also explored, finding that preterm birth and other like variables relate to poor gross motor development. Levels of preterm birth are explored for gross motor outcomes, indicating that moderate to late preterm and very preterm children have the highest risk of delay.

From construction efforts of the interRAI 0-3, all aspects of this work relate to the developmental trajectory of children under the age of four. This is a significant time for the biological unfolding of skills, but also a time for which social services and support stand to gain the most impact. Certainly, this period of life is one in which assessment and early intervention can best support children's outcomes (Mash & Barkley, 2014).

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APPENDIX A. Developmental Milestone Chart

| Age of the Child | Expressive and Receptive Language | Gross Motor | Fine Motor | Social-Emotional | Cognition |
|---|---|---|---|---|---|
| **0-2 Months** *(Birth to 1 month and 30 days)* | **Crying** – cries are diverse and may reflect various needs (e.g. hunger, dirty diaper)<br>**Smiling** – smiles reciprocally to positive speech or facial expressions.<br>**Vocalizing** – sighs**,** coos, gurgles<br>**Vocalizing** – sighs, coos, gurgles in response to caregiver(s) talking<br>**Startle reaction –** startles in response to loud noises | **Moro reflex –** startles in response to a sudden sensation of falling<br>**Movement –** moves trunk and extremities while in supine position<br>**Movement** – moves head from side to side while in prone position<br>**Lifts head** – raises head briefly while lying in prone position | **Resting position** – rests hands with open palm<br>**Grasping –** momentarily uses a palmer grasp to hold an object, clothing or finger | **Self-regulation** – sucks on hands, fingers, or soother to calm him/herself temporarily<br>**Other regulation** – child is soothed by caregiver<br>**Smiling –** smiles spontaneously<br>**Laughing –** laughs spontaneously<br>**Peripheral awareness** – plays with extremities | **Visual tracking** – orients eyes to track caregiver(s) face |

| Age of the Child | Expressive and Receptive Language | Gross Motor | Fine Motor | Social-Emotional | Cognition |
|---|---|---|---|---|---|
| **2-4 Months**<br>*(2 months to 3 months and 30 days)* | **Crying** – cries are diverse and may reflect various needs (e.g. hunger, dirty diaper)<br>**Laughing** – laughs at pleasurable stimuli<br>**Vocalizing –** vocalizes toward objects or people<br>**Attending** – turns toward loud sounds | **Lifts head** – raises head briefly while lying in prone position<br>**Movement** – moves head while lying in supine position<br>**Movement** – moves head while lying in prone position<br>**Lifts head** – raises head while lying in prone position<br>**Lifts chest** – lifts head and chest with upper body support from prone position<br>**Head control —** holds head stable when pulled to sitting position | **Resting position** – rests hands with open palm<br>**Grasping –** momentarily uses a palmer grasp to hold an object, clothing or finger<br>**Grasping** – uses palmar grasp to hold desired toys<br>**Reaching** – reaches forward for nearby or offered toys<br>**Reaching & Grabbing** – reaches and grabs objects within arms-reach | **Self-regulation** – sucks on hands, fingers, or soother to calm him/herself temporarily<br>**Other regulation** – child is soothed by caregiver<br>**Smiling –** smiles spontaneously<br>**Laughing –** laughs spontaneously<br>**Peripheral awareness** – plays with extremities<br>**Attending** – stops vocalizing or crying to listen to an unfamiliar voice<br>**Self-regulation** – regulates response within 30 minutes (e.g., child may suck thumb, seek desired toy) | **Visual tracking** – orients eyes to track caregiver(s) face<br>**Visual tracking** – tracks objects |

| Age of the Child | Expressive and Receptive Language | Gross Motor | Fine Motor | Social-Emotional | Cognition |
|---|---|---|---|---|---|
| **4-6 Months**<br>*(4 months to 5 months and 30 days)* | **Laughing** – laughs at pleasurable stimuli<br>**Vocalizing –** vocalizes toward objects or people<br>**Attending** – turns toward loud sounds<br>**Vocalizing** – makes low-pitched mumbling or grunting sounds | **Lifts chest** – lifts head and chest with upper body support from prone position<br>**Head control —** holds head stable when pulled to sitting position<br>**Movement** – joins hands while laying in supine position<br>**Movement** – raises legs while in supine position<br>**Lifts chest** – lifts chest completely with unbent arms from prone position<br>**Head control** — holds head stable in supported sitting position **Sitting** – sits in a stable position with arm support<br>**Rolling** – rolls from prone to supine position | **Grasping** – uses palmar grasp to hold desired toys<br>**Reaching** – reaches forward for nearby or offered toys<br>**Reaching & Grabbing** – reaches and grabs objects within arms-reach<br>**Grasping** – attempts to scoop tiny objects in an overhand motion | **Self-regulation** – sucks on hands, fingers, or soother to calm him/herself temporarily<br>**Other regulation** – child is soothed by caregiver<br>**Smiling –** smiles spontaneously<br>**Laughing –** laughs spontaneously<br>**Attending** – stops vocalizing or crying to listen to an unfamiliar voice<br>**Self-regulation** – regulates response within 30 minutes (e.g., child may suck thumb, seek desired toy) | **Visual tracking** – tracks objects<br>**Novelty** – interest in new objects and environments<br>**Sensory exploration** – explores objects by mouth<br>**Banging** – using cause and effect to explore toys |

| Age of the Child | Expressive and Receptive Language | Gross Motor | Fine Motor | Social-Emotional | Cognition |
|---|---|---|---|---|---|
| **6-8 Months**<br>*(6 months to 7 months and 30 days)* | **Attending** – turns toward loud sounds<br>**Babbling** – babbles with consonants e.g., "ba, ga")<br>**Attending** – responds to name (e.g., directs focus away from current activity)<br>**Attending** – turns to look in different direction from play when name is called (e.g., directs focus away from current activity and orients towards cue)<br>**Directions** – responds to deeper tones expressing simple directions (e.g., "no") | **Head control** — holds head stable in supported sitting position<br>**Sitting** – sits in a stable position with arm support<br>**Creeping/Crawling** - lifts body from prone position onto forearms or hands and knees<br>**Standing** - stands with support<br>**Rolling** –rolls from supine to prone position while adjusting arms in front of the body<br>**Crawling** – uses various ways of crawling to move forward (e.g., creeping, crawling, scooting) | **Grasping** – uses palmar grasp to hold desired toys<br>**Reaching & Grabbing** – reaches and grabs objects within arms-reach<br>**Grasping** – attempts to scoop tiny objects in an overhand motion<br>**Grasping –** scoops and holds tiny objects in an overhand motion<br>**Grasping –** picks up small objects with fingertips<br>**Grasping** – uses one hand to pick up a small object<br>**Coordination** – transfers objects hand to hand | **Self-regulation** – sucks on hands, fingers, or soother to calm him/herself temporarily<br>**Other regulation** – child is soothed by caregiver<br>**Smiling –** smiles spontaneously<br>**Laughing –** laughs spontaneously<br>**Attending** – stops vocalizing or crying to listen to an unfamiliar voice<br>**Self-regulation** – regulates response within 30 minutes (e.g., child may suck thumb, seek desired toy)<br>**Social interest** – actively interested in playing with familiar people | **Novelty** – interest in new objects and environments<br>**Sensory exploration** – explores objects by mouth<br>**Banging** – using cause and effect to explore toys |

| Age of the Child | Expressive and Receptive Language | Gross Motor | Fine Motor | Social-Emotional | Cognition |
|---|---|---|---|---|---|
| **6-8 Months** *(6 months to 7 months and 30 days) [Continued]* | | | | **Spontaneous play** – engages in spontaneous play **Turn-taking** – partakes in socially reciprocal games **Stranger anxiety** – will avoid unfamiliar people | |

| Age of the Child | Expressive and Receptive Language | Gross Motor | Fine Motor | Social-Emotional | Cognition |
|---|---|---|---|---|---|
| **8-10 Months**<br>*(8 months to 9 months and 30 days)* | **Babbling** – babbles with consonants e.g., "ba, ga")<br>**Attending** – responds to name (e.g., directs focus away from current activity)<br>**Attending** – turns to look in different direction from play when name is called (e.g., directs focus away from current activity and orients towards cue)<br>**Directions** – responds to deeper tones expressing simple directions (e.g., "no")<br>**Imitation** – imitates actions, gestures, or sounds of others (e.g., waving, peek-a-boo) | **Sitting** – sits in a stable position with arm support<br>**Creeping/Crawling** - lifts body from prone position onto forearms or hands and knees<br>**Standing** - stands with support<br>**Rolling** –rolls from supine to prone position while adjusting arms in front of the body<br>**Crawling –** uses various ways of crawling to move forward (e.g., creeping, crawling, scooting)<br>**Sitting** – sits in a stable position without arm support | **Grasping** – uses palmar grasp to hold desired toys<br>**Grasping** – attempts to scoop tiny objects in an overhand motion<br>**Grasping –** scoops and holds tiny objects in an overhand motion<br>**Grasping –** picks up small objects with fingertips<br>**Grasping** – uses one hand to pick up a small object<br>**Coordination** – transfers objects hand to hand<br>**Grasping –** picks up tiny objects with fingertips (e.g. food crumbs, peas)<br>**Grasping –** uses pincer grasp to pick up tiny objects | **Self-regulation** – sucks on hands, fingers, or soother to calm him/herself temporarily<br>**Other regulation** – child is soothed by caregiver<br>**Smiling –** smiles spontaneously<br>**Laughing –** laughs spontaneously<br>**Attending** – stops vocalizing or crying to listen to an unfamiliar voice<br>**Self-regulation** – regulates response within 30 minutes (e.g., child may suck thumb, seek desired toy)<br>**Social interest** – actively interested in playing with familiar people | **Novelty** – interest in new objects and environments<br>**Sensory exploration** – explores objects by mouth<br>**Banging** – using cause and effect to explore toys<br>**Object Permanence** – seeks toys that have been hidden in front of him or her |

| Age of the Child | Expressive and Receptive Language | Gross Motor | Fine Motor | Social-Emotional | Cognition |
|---|---|---|---|---|---|
| **8-10 Months** *(8 months to 9 months and 30 days) [Continued]* | **Non-verbal gestures** – uses gestures appropriately, such as waving "bye-bye"<br>**Communicating** – says or signs "mama" or "dada" with reference to mom or dad<br>**Inflection** – varies pitch with non-sensical language (e.g., "uh-GAH")<br>**Directions** – responds to basic verbal directions (e.g., "stop that") | | **Grasping** – grasps objects and releases them voluntarily | **Spontaneous play** – engages in spontaneous play<br>**Turn-taking** – partakes in socially reciprocal games<br>**Stranger anxiety** – will avoid unfamiliar people | |

| Age of the Child | Expressive and Receptive Language | Gross Motor | Fine Motor | Social-Emotional | Cognition |
|---|---|---|---|---|---|
| **10-12 Months** *(10 months to 11 months and 30 days)* | **Babbling** – babbles with consonants e.g., "ba, ga")<br>**Attending** – turns to look in different direction from play when name is called (e.g., directs focus away from current activity and orients towards cue)<br>**Directions** – responds to deeper tones expressing simple directions (e.g., "no")<br>**Imitation** – imitates actions, gestures, or sounds of others (e.g., waving, peek-a-boo)<br>**Non-verbal gestures** – uses gestures appropriately, such as waving "bye-bye" | **Crawling –** uses various ways of crawling to move forward (e.g., creeping, crawling, scooting)<br>**Sitting** – sits in a stable position without arm support<br>**Standing** – lowers from supported standing position and stands back up with control<br>**Standing** – lowers from supported standing position and sits with control<br>**Standing** – stands up without support<br>**Cruising** – cruising using one hand for support<br>**Walking** – walks with support | **Grasping** – attempts to scoop tiny objects in an overhand motion<br>**Grasping –** scoops and holds tiny objects in an overhand motion<br>**Grasping –** picks up small objects with fingertips<br>**Grasping** – uses one hand to pick up a small object<br>**Coordination** – transfers objects hand to hand<br>**Grasping –** picks up tiny objects with fingertips (e.g. food crumbs, peas)<br>**Grasping –** uses pincer grasp to pick up tiny objects<br>**Grasping** – grasps objects and releases them voluntarily | **Other regulation** – child is soothed by caregiver<br>**Attending** – stops vocalizing or crying to listen to an unfamiliar voice<br>**Self-regulation** – regulates response within 30 minutes (e.g., child may suck thumb, seek desired toy)<br>**Social interest** – actively interested in playing with familiar people<br>**Spontaneous play** – engages in spontaneous play<br>**Turn-taking** – partakes in socially reciprocal games<br>**Stranger anxiety** – will avoid unfamiliar people | **Banging** – using cause and effect to explore toys<br>**Object Permanence** – seeks toys that have been hidden in front of him or her<br>**Filling or dumping –** adds objects or materials into a container or dumps them out |

| Age of the Child | Expressive and Receptive Language | Gross Motor | Fine Motor | Social-Emotional | Cognition |
|---|---|---|---|---|---|
| **10-12 Months** *(10 months to 11 months and 30 days) [Continued]* | **Communicating** – says or signs "mama" or "dada" with reference to mom or dad<br>**Inflection** – varies pitch with non-sensical language (e.g., "uh-GAH")<br>**Directions** – responds to basic verbal directions (e.g., "stop that")<br>**Evoking response** – makes noise to get attention<br>**Babbling** – babbles with two syllable consonants (e.g., "ba-ba," or "ga-ga")<br>**Pointing** – requests desired items by pointing<br>**Responding** – looks at objects that are labelled (e.g., "this is a car?") | **Walking** – walks without support, often falling | **Grasping** – turns pages of a book with help | | |

| Age of the Child | Expressive and Receptive Language | Gross Motor | Fine Motor | Social-Emotional | Cognition |
|---|---|---|---|---|---|
| **10-12 Months** *(10 months to 11 months and 30 days) [Continued]* | **Directions** – follows directions *with gestures* (e.g. "Go get your ball" while pointing) | | | | |

| Age of the Child | Expressive and Receptive Language | Gross Motor | Fine Motor | Social-Emotional | Cognition |
|---|---|---|---|---|---|
| **12-14 Months** *(12 months to 13 months and 30 days)* | **Attending** – turns to look in different direction from play when name is called (e.g., directs focus away from current activity and orients towards cue)<br>**Non-verbal gestures** – uses gestures appropriately, such as waving "bye-bye"<br>**Communicating** – says or signs "mama" or "dada" with reference to mom or dad<br>**Inflection** – varies pitch with non-sensical language (e.g., "uh-GAH")<br>**Evoking response** – makes noise to get attention<br>**Babbling** – babbles with two syllable consonants (e.g., "ba-ba," or "ga-ga") | **Standing** – lowers from supported standing position and stands back up with control<br>**Standing** – lowers from supported standing position and sits with control<br>**Standing** – stands up without support<br>**Walking** – walks with support<br>**Walking** – walks without support, often falling<br>**Standing** – lowers from standing position and stands back up without support<br>**Walking** – walks without support<br>**Climbing** – climbs stairs or furniture in crawling position | **Grasping –** uses pincer grasp to pick up tiny objects<br>**Grasping** – grasps objects and releases them voluntarily<br>**Grasping** – turns pages of a book with help<br>**Stacking** – grasps and stacks hand-size objects<br>**Pre-writing** – scribbles with a writing utensil | **Other regulation** – child is soothed by caregiver<br>**Attending** – stops vocalizing or crying to listen to an unfamiliar voice<br>**Self-regulation** – regulates response within 30 minutes (e.g., child may suck thumb, seek desired toy)<br>**Social interest** – actively interested in playing with familiar people<br>**Spontaneous play** – engages in spontaneous play<br>**Turn-taking** – partakes in socially reciprocal games<br>**Stranger anxiety** – will avoid unfamiliar people | **Banging** – using cause and effect to explore toys<br>**Object Permanence** – seeks toys that have been hidden in front of him or her<br>**Filling or dumping –** adds objects or materials into a container or dumps them out<br>**Attention span –** spends at least five minutes with an interesting toy |

| Age of the Child | Expressive and Receptive Language | Gross Motor | Fine Motor | Social-Emotional | Cognition |
|---|---|---|---|---|---|
| **12-14 Months** *(12 months to 13 months and 30 days) [Continued]* | **Pointing** – requests desired items by pointing<br>**Responding** – looks at objects that are labelled (e.g., "this is a car?")<br>**Directions** – follows directions *with gestures* (e.g. "Go get your ball" while pointing)<br>**Babbling** – babbles repetitively combining vowels and consonants (e.g. "bah, BAH, ah-buh, bah")<br>**Non-verbal gestures** – shakes head to communicate yes or no<br>**Communicating** – uses at least 4 words or signs<br>**Listening** – shows interest in listening to stories | | | | |

| Age of the Child | Expressive and Receptive Language | Gross Motor | Fine Motor | Social-Emotional | Cognition |
|---|---|---|---|---|---|
| **14-16 Months** *(14 months to 15 months and 30 days)* | **Pointing** – requests desired items by pointing<br>**Directions** – follows directions *with gestures* (e.g. "Go get your ball" while pointing)<br>**Non-verbal gestures** – shakes head to communicate yes or no<br>**Communicating** – uses at least 4 words or signs<br>**Listening** – shows interest in listening to stories<br>**Communicating** – uses at least 8 words or signs<br>**Imitation** – repeats short sayings (e.g. "nighty-night") | **Standing** – lowers from supported standing position and sits with control<br>**Standing** – stands up without support<br>**Walking** – walks without support, often falling<br>**Standing** – lowers from standing position and stands back up without support<br>**Walking** – walks without support<br>**Climbing** – climbs stairs or furniture in crawling position | **Grasping –** uses pincer grasp to pick up tiny objects<br>**Grasping** – grasps objects and releases them voluntarily<br>**Grasping** – turns pages of a book with help<br>**Stacking** – grasps and stacks hand-size objects<br>**Pre-writing** – scribbles with a writing utensil | **Attending** – stops vocalizing or crying to listen to an unfamiliar voice<br>**Social interest** – actively interested in playing with familiar people<br>**Spontaneous play** – engages in spontaneous play<br>**Turn-taking** – partakes in socially reciprocal games<br>**Stranger anxiety** – will avoid unfamiliar people<br>**Affection** – seeks out affection from primary caregiver as needed (e.g., a hug)<br>**Preference** – becomes upset and seeks out primary caregiver when primary caregiver leaves | **Filling or dumping –** adds objects or materials into a container or dumps them out<br>**Attention span –** spends at least five minutes with an interesting toy |

| Age of the Child | Expressive and Receptive Language | Gross Motor | Fine Motor | Social-Emotional | Cognition |
|---|---|---|---|---|---|
| **14-16 Months** *(14 months to 15 months and 30 days) [Continued]* | **Directions** – responds to more complex verbal directions (e.g., "Go find your shoes in the closet") | | | **Self-regulation** – regulates response within 20 minutes (e.g., child may suck thumb, seek desired toy) | |

| Age of the Child | Expressive and Receptive Language | Gross Motor | Fine Motor | Social-Emotional | Cognition |
|---|---|---|---|---|---|
| **16-18 Months** *(16 months to 17 months and 30 days)* | **Pointing** – requests desired items by pointing<br>**Listening** – shows interest in listening to stories<br>**Communicating** – uses at least 8 words or signs<br>**Imitation** – repeats short sayings (e.g. "nighty-night")<br>**Directions** – responds to more complex verbal directions (e.g., "Go find your shoes in the closet")<br>**Communicating** – combines two words or signs into short phrases (e.g. "baby sleep") | **Standing** – stands up without support<br>**Standing** – lowers from standing position and stands back up without support<br>**Walking** – walks without support<br>**Climbing** – climbs stairs or furniture in crawling position<br>**Climbing** – descends stairs using one hand for support | **Grasping –** uses pincer grasp to pick up tiny objects<br>**Grasping** – grasps objects and releases them voluntarily<br>**Grasping** – turns pages of a book with help<br>**Stacking** – grasps and stacks hand-size objects<br>**Pre-writing** – scribbles with a writing utensil | **Social interest** – actively interested in playing with familiar people<br>**Spontaneous play** – engages in spontaneous play<br>**Turn-taking** – partakes in socially reciprocal games<br>**Stranger anxiety** – will avoid unfamiliar people<br>**Affection** – seeks out affection from primary caregiver as needed (e.g., a hug)<br>**Preference** – becomes upset and seeks out primary caregiver when primary caregiver leaves<br>**Self-regulation** – regulates response within 20 minutes (e.g., child may suck thumb, seek desired toy) | **Filling or dumping –** adds objects or materials into a container or dumps them out<br>**Attention span –** spends at least five minutes with an interesting toy<br>**Tool use –** uses objects as a tool to attempt problem solving |

| Age of the Child | Expressive and Receptive Language | Gross Motor | Fine Motor | Social-Emotional | Cognition |
|---|---|---|---|---|---|
| **18-20 Months** *(18 months to 19 months and 30 days)* | **Pointing** – requests desired items by pointing<br>**Imitation** – repeats short sayings (e.g. "nighty-night")<br>**Communicating** – uses at least 15 words or signs<br>**Communicating** – combines two or three words or signs into short phrases (e.g. "doggie go outside")<br>**Labelling –** labels pictures of commonly known objects (e.g. ball, book, shoe)<br>**Directions –** follows three to four entirely verbal directions (e.g. ""find your blanket," "sit down with mama") | **Standing** – lowers from standing position and stands back up without support<br>**Walking** – walks without support<br>**Climbing** – climbs stairs or furniture in crawling position<br>**Climbing** – descends stairs using one hand for support | **Grasping –** uses pincer grasp to pick up tiny objects<br>**Grasping** – grasps objects and releases them voluntarily<br>**Stacking** – grasps and stacks hand-size objects<br>**Pre-writing** – scribbles with a writing utensil<br>**Grasping** – turns pages of a book without help | **Social interest** – actively interested in playing with familiar people<br>**Spontaneous play** – engages in spontaneous play<br>**Affection** – seeks out affection from primary caregiver as needed (e.g., a hug)<br>**Preference** – becomes upset and seeks out primary caregiver when primary caregiver leaves<br>**Self-regulation** – regulates response within 20 minutes (e.g., child may suck thumb, seek desired toy) | **Filling or dumping –** adds objects or materials into a container or dumps them out<br>**Attention span –** spends at least five minutes with an interesting toy<br>**Tool use –** uses objects as a tool to attempt problem solving<br>**Functional tool use –** correctly uses tools for their intended purpose<br>**Labelling –** identifies the location of one or more body parts (e.g., nose) |

| Age of the Child | Expressive and Receptive Language | Gross Motor | Fine Motor | Social-Emotional | Cognition |
|---|---|---|---|---|---|
| **20-22 Months**<br>*(20 months to 21 months and 30 days)* | **Imitation** – repeats short sayings (e.g. "nighty-night")<br>**Communicating** – combines two or three words or signs into short phrases (e.g. "doggie go outside")<br>**Labelling –** labels pictures of commonly known objects (e.g. ball, book, shoe)<br>**Directions –** follows three to four entirely verbal directions (e.g. ""find your blanket," "sit down with mama")<br>**Communicating** – uses 20 to 50 words or signs<br>**Responding** – responds to simple questions (e.g. "what's mommy doing?") | **Walking** – walks without support<br>**Climbing** – climbs stairs or furniture in crawling position<br>**Climbing** – descends stairs using one hand for support<br>**Running** – runs with moderate stability<br>**Climbing** – ascends stairs using one hand for support | **Grasping –** uses pincer grasp to pick up tiny objects<br>**Grasping** – grasps objects and releases them voluntarily<br>**Stacking** – grasps and stacks hand-size objects<br>**Pre-writing** – scribbles with a writing utensil<br>**Grasping** – turns pages of a book without help | **Social interest** – actively interested in playing with familiar people<br>**Spontaneous play** – engages in spontaneous play<br>**Affection** – seeks out affection from primary caregiver as needed (e.g., a hug)<br>**Preference** – becomes upset and seeks out primary caregiver when primary caregiver leaves<br>**Self-regulation** – regulates response within 20 minutes (e.g., child may suck thumb, seek desired toy)<br>**Pride** – child shows expressions of pride when successful at an activity | **Filling or dumping –** adds objects or materials into a container or dumps them out<br>**Attention span –** spends at least five minutes with an interesting toy<br>**Functional tool use –** correctly uses tools for their intended purpose<br>**Ordering –** lines up items (e.g. magnet letters, blocks or trucks)<br>**Labelling –** identifies the location of three or more body parts (e.g., nose, eyes, head) |

| Age of the Child | Expressive and Receptive Language | Gross Motor | Fine Motor | Social-Emotional | Cognition |
|---|---|---|---|---|---|
| **20-22 Months** *(20 months to 21 months and 30 days) [Continued]* | **Understandable Speech** – speech can be understood by an adult at least 25% of the time | | | **Pretend play** – engages in pretend play (e.g., uses blocks to represent food items, feeding a doll) | |

| Age of the Child | Expressive and Receptive Language | Gross Motor | Fine Motor | Social-Emotional | Cognition |
|---|---|---|---|---|---|
| **22-24 Months**<br>*(22 months to 23 months and 30 days)* | **Imitation** – repeats short sayings (e.g. "nighty-night")<br>**Communicating** – combines two or three words or signs into short phrases (e.g. "doggie go outside")<br>**Labelling –** labels pictures of commonly known objects (e.g. ball, book, shoe)<br>**Directions –** follows three to four entirely verbal directions (e.g. ""find your blanket," "sit down with mama")<br>**Communicating** – uses 20 to 50 words or signs<br>**Responding** – responds to simple questions (e.g. "what's mommy doing?") | **Climbing** – descends stairs using one hand for support<br>**Running** – runs with moderate stability<br>**Climbing** – ascends stairs using one hand for support<br>**Jumping** – jumps off of the ground with two feet in place<br>**Kicking** – swings leg forward to kick | **Stacking** – grasps and stacks hand-size objects<br>**Pre-writing** – scribbles with a writing utensil<br>**Grasping** – turns pages of a book without help<br>**Grasping & twisting** – manipulates grasp to twist objects<br>**Coordination and manipulation** – laces large objects | **Social interest** – actively interested in playing with familiar people<br>**Spontaneous play** – engages in spontaneous play<br>**Affection** – seeks out affection from primary caregiver as needed (e.g., a hug)<br>**Preference** – becomes upset and seeks out primary caregiver when primary caregiver leaves<br>**Self-regulation** – regulates response within 20 minutes (e.g., child may suck thumb, seek desired toy)<br>**Pride** – child shows expressions of pride when successful at an activity | **Filling or dumping –** adds objects or materials into a container or dumps them out<br>**Functional tool use –** correctly uses tools for their intended purpose<br>**Ordering –** lines up items (e.g. magnet letters, blocks or trucks)<br>**Attention span –** spends at least ten minutes with an interesting toy |

| Age of the Child | Expressive and Receptive Language | Gross Motor | Fine Motor | Social-Emotional | Cognition |
|---|---|---|---|---|---|
| **22-24 Months** *(22 months to 23 months and 30 days) [Continued]* | **Understandable Speech** – speech can be understood by an adult at least 25% of the time | | | **Pretend play** – engages in pretend play (e.g., uses blocks to represent food items, feeding a doll)<br>**Helping behaviours** – engaged in helping behaviours (e.g. clean up toys)<br>**Emotional referencing** – examines the emotional reactions and facial expressions of others | |

| Age of the Child | Expressive and Receptive Language | Gross Motor | Fine Motor | Social-Emotional | Cognition |
|---|---|---|---|---|---|
| **24-26 Months** *(24 months to 25 months and 30 days)* | **Communicating** – combines two or three words or signs into short phrases (e.g. "doggie go outside")<br>**Labelling –** labels pictures of commonly known objects (e.g. ball, book, shoe)<br>**Directions –** follows three to four entirely verbal directions (e.g. ""find your blanket," "sit down with mama")<br>**Responding** – responds to simple questions (e.g. "what's mommy doing?")<br>**Understandable Speech** – speech can be understood by an adult at least 25% of the time | **Running** – runs with moderate stability<br>**Jumping** – jumps off of the ground with two feet in place<br>**Kicking** – swings leg forward to kick<br>**Climbing** – ascends or descends stairs with limited support, placing two feet on each step<br>**Climbing** – ascends or descends stairs with limited support, alternating feet | **Stacking** – grasps and stacks hand-size objects<br>**Grasping** – turns pages of a book without help<br>**Grasping & twisting** – manipulates grasp to twist objects<br>**Coordination and manipulation** – laces large objects<br>**Pre-writing** – draws a moderately straight line in a vertical or horizontal fashion<br>**Coordination and manipulation** – laces small objects | **Social interest** – actively interested in playing with familiar people<br>**Spontaneous play** – engages in spontaneous play<br>**Affection** – seeks out affection from primary caregiver as needed (e.g., a hug)<br>**Preference** – becomes upset and seeks out primary caregiver when primary caregiver leaves<br>**Self-regulation** – regulates response within 20 minutes (e.g., child may suck thumb, seek desired toy)<br>**Pride** – child shows expressions of pride when successful at an activity | **Filling or dumping –** adds objects or materials into a container or dumps them out<br>**Ordering –** lines up items (e.g. magnet letters, blocks or trucks)<br>**Attention span –** spends at least ten minutes with an interesting toy<br>**Spatial concepts –** understands the difference between "open" and "shut" |

| Age of the Child | Expressive and Receptive Language | Gross Motor | Fine Motor | Social-Emotional | Cognition |
|---|---|---|---|---|---|
| **24-26 Months** *(24 months to 25 months and 30 days) [Continued]* | **Communicating** – uses 50 to 200 words or signs<br>**Personal pronouns** – uses personal pronouns (e.g., "me", "my/mine" or "I")<br>**Prepositions** – uses two prepositions in common language (e.g., "on", "under", "off", "in", "out") | | | **Pretend play** – engages in pretend play (e.g., uses blocks to represent food items, feeding a doll)<br>**Helping behaviours** – engaged in helping behaviours (e.g. clean up toys)<br>**Emotional referencing** – examines the emotional reactions and facial expressions of others | |

| Age of the Child | Expressive and Receptive Language | Gross Motor | Fine Motor | Social-Emotional | Cognition |
|---|---|---|---|---|---|
| **26-28 Months** *(26 months to 27 months and 30 days)* | **Communicating** – combines two or three words or signs into short phrases (e.g. "doggie go outside")<br>**Labelling –** labels pictures of commonly known objects (e.g. ball, book, shoe)<br>**Directions –** follows three to four entirely verbal directions (e.g. ""find your blanket," "sit down with mama")<br>**Responding** – responds to simple questions (e.g. "what's mommy doing?")<br>**Understandable Speech** – speech can be understood by an adult at least 25% of the time | **Running** – runs with moderate stability<br>**Jumping** – jumps off of the ground with two feet in place<br>**Kicking** – swings leg forward to kick<br>**Climbing** – ascends or descends stairs with limited support, placing two feet on each step<br>**Climbing** – ascends or descends stairs with limited support, alternating feet | **Stacking** – grasps and stacks hand-size objects<br>**Grasping** – turns pages of a book without help<br>**Grasping & twisting** – manipulates grasp to twist objects<br>**Coordination and manipulation** – laces large objects<br>**Pre-writing** – draws a moderately straight line in a vertical or horizontal fashion<br>**Coordination and manipulation** – laces small objects | **Social interest** – actively interested in playing with familiar people<br>**Spontaneous play** – engages in spontaneous play<br>**Affection** – seeks out affection from primary caregiver as needed (e.g., a hug)<br>**Self-regulation** – regulates response within 20 minutes (e.g., child may suck thumb, seek desired toy)<br>**Pride** – child shows expressions of pride when successful at an activity<br>**Pretend play** – engages in pretend play (e.g., uses blocks to represent food items, feeding a doll) | **Ordering –** lines up items (e.g. magnet letters, blocks or trucks)<br>**Attention span –** spends at least ten minutes with an interesting toy<br>**Spatial concepts –** understands the difference between "open" and "shut"<br>**Spatial concepts –** understands the difference between "in" and "out"<br>**Labelling –** identifies the location of seven or more body parts (e.g., nose, eyes, head, ears, legs, arms, neck) |

| Age of the Child | Expressive and Receptive Language | Gross Motor | Fine Motor | Social-Emotional | Cognition |
|---|---|---|---|---|---|
| **26-28 Months** *(26 months to 27 months and 30 days) [Continued]* | **Communicating** – uses 50 to 200 words or signs<br>**Personal pronouns** – uses personal pronouns (e.g., "me", "my/mine" or "I")<br>**Prepositions** – uses two prepositions in common language (e.g., "on", "under", "off", "in", "out") | | | **Helping behaviours** – engaged in helping behaviours (e.g. clean up toys)<br>**Emotional referencing** – examines the emotional reactions and facial expressions of others<br>**Preference** – seeks out primary caregiver when primary caregiver leaves | |

| Age of the Child | Expressive and Receptive Language | Gross Motor | Fine Motor | Social-Emotional | Cognition |
|---|---|---|---|---|---|
| **28-30 Months** *(28 months to 29 months and 30 days)* | **Communicating** – combines two or three words or signs into short phrases (e.g. "doggie go outside")<br>**Labelling –** labels pictures of commonly known objects (e.g. ball, book, shoe)<br>**Directions –** follows three to four entirely verbal directions (e.g. ""find your blanket," "sit down with mama")<br>**Responding** – responds to simple questions (e.g. "what's mommy doing?")<br>**Communicating** – uses 50 to 200 words or signs | **Running** – runs with moderate stability<br>**Jumping** – jumps off of the ground with two feet in place<br>**Kicking** – swings leg forward to kick<br>**Climbing** – ascends or descends stairs with limited support, placing two feet on each step<br>**Climbing** – ascends or descends stairs with limited support, alternating feet | **Grasping** – turns pages of a book without help<br>**Grasping & twisting** – manipulates grasp to twist objects<br>**Pre-writing** – draws a moderately straight line in a vertical or horizontal fashion<br>**Coordination and manipulation** – laces small objects<br>**Pre-writing** – draws a moderately round circle | **Social interest** – actively interested in playing with familiar people<br>**Spontaneous play** – engages in spontaneous play<br>**Affection** – seeks out affection from primary caregiver as needed (e.g., a hug)<br>**Pride** – child shows expressions of pride when successful at an activity<br>**Pretend play** – engages in pretend play (e.g., uses blocks to represent food items, feeding a doll)<br>**Helping behaviours** – engaged in helping behaviours (e.g. clean up toys) | **Ordering –** lines up items (e.g. magnet letters, blocks or trucks)<br>**Attention span –** spends at least ten minutes with an interesting toy<br>**Spatial concepts –** understands the difference between "open" and "shut"<br>**Spatial concepts –** understands the difference between "in" and "out"<br>**Labelling –** identifies the location of seven or more body parts (e.g., nose, eyes, head, ears, legs, arms, neck) |

| Age of the Child | Expressive and Receptive Language | Gross Motor | Fine Motor | Social-Emotional | Cognition |
|---|---|---|---|---|---|
| **28-30 Months** *(28 months to 29 months and 30 days) [Continued]* | **Personal pronouns** – uses personal pronouns (e.g., "me", "my/mine" or "I")<br>**Prepositions** – uses two prepositions in common language (e.g., "on", "under", "off", "in", "out")<br>**Understandable Speech** – speech can be understood by an adult at least 50% of the time<br>**Action verbs** – begins describing the function of objects or the actions of people (e.g., "car driving")<br>**Communicating** – combines three or four words or signs into short phrases (e.g., "apple slice please") | | | **Emotional referencing** – examines the emotional reactions and facial expressions of others<br>**Preference** – seeks out primary caregiver when primary caregiver leaves<br>**Self-regulation** – regulates response within 15 minutes (e.g., child may suck thumb, seek desired toy) | |

| Age of the Child | Expressive and Receptive Language | Gross Motor | Fine Motor | Social-Emotional | Cognition |
|---|---|---|---|---|---|
| **30-32 Months**<br>*(30 months to 31 months and 30 days)* | **Labelling –** labels pictures of commonly known objects (e.g. ball, book, shoe)<br>**Directions –** follows three to four entirely verbal directions (e.g. ""find your blanket," "sit down with mama")<br>**Responding** – responds to simple questions (e.g. "what's mommy doing?")<br>**Personal pronouns** – uses personal pronouns (e.g., "me", "my/mine" or "I")<br>**Prepositions** – uses two prepositions in common language (e.g., "on", "under", "off", "in", "out") | **Running** – runs with moderate stability<br>**Jumping** – jumps off of the ground with two feet in place<br>**Kicking** – swings leg forward to kick<br>**Climbing** – ascends or descends stairs with limited support, alternating feet<br>**Standing** – briefly stand on one foot without support | **Pre-writing** – draws a moderately straight line in a vertical or horizontal fashion<br>**Coordination and manipulation** – laces small objects<br>**Pre-writing** – draws a moderately round circle<br>**Grasping** – turns single pages of a book without help | **Social interest** – actively interested in playing with familiar people<br>**Spontaneous play** – engages in spontaneous play<br>**Affection** – seeks out affection from primary caregiver as needed (e.g., a hug)<br>**Pride** – child shows expressions of pride when successful at an activity<br>**Pretend play** – engages in pretend play (e.g., uses blocks to represent food items, feeding a doll)<br>**Helping behaviours** – engaged in helping behaviours (e.g. clean up toys) | **Ordering –** lines up items (e.g. magnet letters, blocks or trucks)<br>**Spatial concepts –** understands the difference between "open" and "shut"<br>**Spatial concepts –** understands the difference between "in" and "out"<br>**Labelling –** identifies the location of seven or more body parts (e.g., nose, eyes, head, ears, legs, arms, neck)<br>**Memory –** able to recall what happens "next" during a routine |

| Age of the Child | Expressive and Receptive Language | Gross Motor | Fine Motor | Social-Emotional | Cognition |
|---|---|---|---|---|---|
| **30-32 Months** *(30 months to 31 months and 30 days) [Continued]* | **Understandable Speech** – speech can be understood by an adult at least 50% of the time<br>**Action verbs** – begins describing the function of objects or the actions of people (e.g., "car driving")<br>**Communicating** – combines three or four words or signs into short phrases (e.g., "apple slice please")<br>**Communicating** – uses at least 500 words or signs<br>**Communicating** – verbalizes or signs first name | | | **Emotional referencing** – examines the emotional reactions and facial expressions of others<br>**Preference** – seeks out primary caregiver when primary caregiver leaves<br>**Self-regulation** – regulates response within 15 minutes (e.g., child may suck thumb, seek desired toy) | |

| Age of the Child | Expressive and Receptive Language | Gross Motor | Fine Motor | Social-Emotional | Cognition |
|---|---|---|---|---|---|
| **32-34 Months** *(32 months to 33 months and 30 days)* | **Labelling –** labels pictures of commonly known objects (e.g. ball, book, shoe)<br>**Directions –** follows three to four entirely verbal directions (e.g. ""find your blanket," "sit down with mama")<br>**Responding** – responds to simple questions (e.g. "what's mommy doing?")<br>**Personal pronouns** – uses personal pronouns (e.g., "me", "my/mine" or "I")<br>**Prepositions** – uses two prepositions in common language (e.g., "on", "under", "off", "in", "out") | **Running** – runs with moderate stability<br>**Jumping** – jumps off of the ground with two feet in place<br>**Kicking** – swings leg forward to kick<br>**Climbing** – ascends or descends stairs with limited support, alternating feet<br>**Standing** – briefly stand on one foot without support<br>**Throwing** – throws a ball a short distance forward, while standing in one place | **Pre-writing** – draws a moderately straight line in a vertical or horizontal fashion<br>**Coordination and manipulation** – laces small objects<br>**Pre-writing** – draws a moderately round circle<br>**Grasping** – turns single pages of a book without help<br>**Cutting** – manipulates child-sized scissors | **Social interest** – actively interested in playing with familiar people<br>**Spontaneous play** – engages in spontaneous play<br>**Affection** – seeks out affection from primary caregiver as needed (e.g., a hug)<br>**Pride** – child shows expressions of pride when successful at an activity<br>**Pretend play** – engages in pretend play (e.g., uses blocks to represent food items, feeding a doll)<br>**Helping behaviours** – engaged in helping behaviours (e.g. clean up toys) | **Ordering –** lines up items (e.g. magnet letters, blocks or trucks)<br>**Spatial concepts –** understands the difference between "open" and "shut"<br>**Spatial concepts –** understands the difference between "in" and "out"<br>**Labelling –** identifies the location of seven or more body parts (e.g., nose, eyes, head, ears, legs, arms, neck)<br>**Memory –** able to recall what happens "next" during a routine |

| Age of the Child | Expressive and Receptive Language | Gross Motor | Fine Motor | Social-Emotional | Cognition |
|---|---|---|---|---|---|
| **32-34 Months** *(32 months to 33 months and 30 days) [Continued]* | **Action verbs** – begins describing the function of objects or the actions of people (e.g., "car driving")<br>**Communicating** – combines three or four words or signs into short phrases (e.g., "apple slice please")<br>**Communicating** – uses at least 500 words or signs<br>**Communicating** – verbalizes or signs first name<br>**Understandable Speech** – speech can be understood by an adult at least 75% of the time | | | **Emotional referencing** – examines the emotional reactions and facial expressions of others<br>**Self-regulation** – regulates response within 15 minutes (e.g., child may suck thumb, seek desired toy)<br>**Emotion labelling** – labels emotions of self and others<br>**Peer relations** – engages in acceptable play with other children<br>**Peer relations** – engages with one peer consistently | |

| Age of the Child | Expressive and Receptive Language | Gross Motor | Fine Motor | Social-Emotional | Cognition |
|---|---|---|---|---|---|
| **34-36 Months**<br>*(34 months to 35 months and 30 days)* | **Labelling –** labels pictures of commonly known objects (e.g. ball, book, shoe)<br>**Directions –** follows three to four entirely verbal directions (e.g. ““find your blanket,” “sit down with mama”)<br>**Personal pronouns** – uses personal pronouns (e.g., “me”, “my/mine” or “I”)<br>**Action verbs** – begins describing the function of objects or the actions of people (e.g., “car driving”)<br>**Communicating** – combines three or four words or signs into short phrases (e.g., “apple slice please”) | **Kicking** – swings leg forward to kick<br>**Climbing** – ascends or descends stairs with limited support, alternating feet<br>**Standing** – briefly stand on one foot without support<br>**Throwing** – throws a ball a short distance forward, while standing in one place<br>**Jumping** – jumps forward and off the ground with two feet in place | **Pre-writing** – draws a moderately straight line in a vertical or horizontal fashion<br>**Coordination and manipulation** – laces small objects<br>**Pre-writing** – draws a moderately round circle<br>**Grasping** – turns single pages of a book without help<br>**Cutting** – manipulates child-sized scissors | **Social interest** – actively interested in playing with familiar people<br>**Spontaneous play** – engages in spontaneous play<br>**Affection** – seeks out affection from primary caregiver as needed (e.g., a hug)<br>**Pride** – child shows expressions of pride when successful at an activity<br>**Pretend play** – engages in pretend play (e.g., uses blocks to represent food items, feeding a doll)<br>**Helping behaviours** – engaged in helping behaviours (e.g. clean up toys) | **Ordering –** lines up items (e.g. magnet letters, blocks or trucks)<br>**Spatial concepts –** understands the difference between “open” and “shut”<br>**Spatial concepts –** understands the difference between “in” and “out”<br>**Memory –** able to recall what happens “next” during a routine<br>**Memory –** able to recall at least two numbers in correct sequence |

| Age of the Child | Expressive and Receptive Language | Gross Motor | Fine Motor | Social-Emotional | Cognition |
|---|---|---|---|---|---|
| **34-36 Months**<br>*(34 months to 35 months and 30 days) [Continued]* | **Understandable Speech** – speech can be understood by an adult at least 75% of the time<br>**Communicating** – verbalizes or signs first and last name<br>**Prepositions** – uses three prepositions in common language (e.g., "on", "under", "off", "in", "out")<br>**Communicating** – uses between 900 to 1000 words or signs | | | **Self-regulation** – regulates response within 15 minutes (e.g., child may suck thumb, seek desired toy)<br>**Emotion labelling** – labels emotions of self and others<br>**Peer relations** – engages in acceptable play with other children<br>**Peer relations** – engages with one peer consistently<br>**Taking Turns** – begins taking turns with peers | |

| Age of the Child | Expressive and Receptive Language | Gross Motor | Fine Motor | Social-Emotional | Cognition |
|---|---|---|---|---|---|
| **36-38 Months**<br>*(36 months to 37 months and 30 days)* | **Directions –** follows three to four entirely verbal directions (e.g. ““find your blanket,” “sit down with mama”)<br>**Personal pronouns** – uses personal pronouns (e.g., “me”, “my/mine” or “I”)<br>**Communicating** – combines three or four words or signs into short phrases (e.g., “apple slice please”)<br>**Understandable Speech** – speech can be understood by an adult at least 75% of the time<br>**Communicating** – verbalizes or signs first and last name | **Kicking** – swings leg forward to kick<br>**Climbing** – ascends or descends stairs with limited support, alternating feet<br>**Standing** – briefly stand on one foot without support<br>**Throwing** – throws a ball a short distance forward, while standing in one place<br>**Jumping** – jumps forward and off the ground with two feet in place | **Coordination and manipulation** – laces small objects<br>**Pre-writing** – draws a moderately round circle<br>**Grasping** – turns single pages of a book without help<br>**Cutting** – manipulates child-sized scissors<br>**Pre-writing** – uses tripod grip while using a writing utensil | **Social interest** – actively interested in playing with familiar people<br>**Spontaneous play** – engages in spontaneous play<br>**Affection** – seeks out affection from primary caregiver as needed (e.g., a hug)<br>**Pride** – child shows expressions of pride when successful at an activity<br>**Pretend play** – engages in pretend play (e.g., uses blocks to represent food items, feeding a doll)<br>**Helping behaviours** – engaged in helping behaviours (e.g. clean up toys) | **Spatial concepts –** understands the difference between “open” and “shut”<br>**Spatial concepts –** understands the difference between “in” and “out”<br>**Memory –** able to recall what happens “next” during a routine<br>**Memory –** able to recall at least two numbers in correct sequence<br>**Manipulating** – connects at least six pieces of a preschool level puzzle correctly<br>**Sorting** – sorts objects with one or more similar characteristic (e.g., similar colour) |

| Age of the Child | Expressive and Receptive Language | Gross Motor | Fine Motor | Social-Emotional | Cognition |
|---|---|---|---|---|---|
| **36-38 Months** *(36 months to 37 months and 30 days) [Continued]* | **Prepositions** – uses three prepositions in common language (e.g., "on", "under", "off", "in", "out")<br>**Communicating** – uses between 900 to 1000 words or signs<br>**Action verbs** – correctly describing the function of objects or the actions of people (e.g., "grandma eating")<br>**Causal Language** – can explain how simple cause and effect events occur (e.g., "cup spill, floor wet") | | | **Self-regulation** – regulates response within 15 minutes (e.g., child may suck thumb, seek desired toy)<br>**Emotion labelling** – labels emotions of self and others<br>**Peer relations** – engages in acceptable play with other children<br>**Peer relations** – engages with one peer consistently<br>**Taking Turns** – begins taking turns with peers | |

| Age of the Child | Expressive and Receptive Language | Gross Motor | Fine Motor | Social-Emotional | Cognition |
|---|---|---|---|---|---|
| **38-40 Months** *(38 months to 39 months and 30 days)* | **Directions –** follows three to four entirely verbal directions (e.g. ""find your blanket," "sit down with mama")<br>**Personal pronouns** – uses personal pronouns (e.g., "me", "my/mine" or "I")<br>**Understandable Speech** – speech can be understood by an adult at least 75% of the time<br>**Communicating** – verbalizes or signs first and last name<br>**Prepositions** – uses three prepositions in common language (e.g., "on", "under", "off", "in", "out") | **Climbing** – ascends or descends stairs with limited support, alternating feet<br>**Standing** – briefly stand on one foot without support<br>**Throwing** – throws a ball a short distance forward, while standing in one place<br>**Jumping** – jumps forward and off the ground with two feet in place<br>**Catching** – opens arms and uses hands and chest to catch a large soft toy or ball | **Pre-writing** – draws a moderately round circle<br>**Grasping** – turns single pages of a book without help<br>**Cutting** – manipulates child-sized scissors<br>**Pre-writing** – uses tripod grip while using a writing utensil | **Social interest** – actively interested in playing with familiar people<br>**Spontaneous play** – engages in spontaneous play<br>**Affection** – seeks out affection from primary caregiver as needed (e.g., a hug)<br>**Pride** – child shows expressions of pride when successful at an activity<br>**Pretend play** – engages in pretend play (e.g., uses blocks to represent food items, feeding a doll)<br>**Helping behaviours** – engaged in helping behaviours (e.g. clean up toys) | **Spatial concepts –** understands the difference between "open" and "shut"<br>**Spatial concepts –** understands the difference between "in" and "out"<br>**Memory –** able to recall what happens "next" during a routine<br>**Memory –** able to recall at least two numbers in correct sequence<br>**Manipulating** – connects at least six pieces of a preschool level puzzle correctly<br>**Sorting** – sorts objects with one or more similar characteristic (e.g., similar colour) |

| Age of the Child | Expressive and Receptive Language | Gross Motor | Fine Motor | Social-Emotional | Cognition |
|---|---|---|---|---|---|
| **38-40 Months**<br>*(38 months to 39 months and 30 days)*<br>*[Continued]* | **Action verbs** – correctly describing the function of objects or the actions of people (e.g., "grandma eating")<br>**Causal Language** – can explain how simple cause and effect events occur (e.g., "cup spill, floor wet")<br>**Communicating** – uses at least 1000 words or signs<br>**Conjunctions** – uses simple transition words appropriately (e.g., "to/too", "because", "and", "but", "so", "or", "then") | | | **Self-regulation** – regulates response within 15 minutes (e.g., child may suck thumb, seek desired toy)<br>**Emotion labelling** – labels emotions of self and others<br>**Peer relations** – engages in acceptable play with other children<br>**Peer relations** – engages with one peer consistently<br>**Taking Turns** – begins taking turns with peers | |

| Age of the Child | Expressive and Receptive Language | Gross Motor | Fine Motor | Social-Emotional | Cognition |
|---|---|---|---|---|---|
| **40-42 Months** *(40 months to 41 months and 30 days)* | **Directions –** follows three to four entirely verbal directions (e.g. ““find your blanket,” “sit down with mama”)<br>**Personal pronouns** – uses personal pronouns (e.g., “me”, “my/mine” or “I”)<br>**Understandable Speech** – speech can be understood by an adult at least 75% of the time<br>**Communicating** – verbalizes or signs first and last name<br>**Prepositions** – uses three prepositions in common language (e.g., “on”, “under”, “off”, “in”, “out”) | **Climbing** – ascends or descends stairs with limited support, alternating feet<br>**Standing** – briefly stand on one foot without support<br>**Throwing** – throws a ball a short distance forward, while standing in one place<br>**Jumping** – jumps forward and off the ground with two feet in place<br>**Catching** – opens arms and uses hands and chest to catch a large soft toy or ball | **Pre-writing** – draws a moderately round circle<br>**Grasping** – turns single pages of a book without help<br>**Cutting** – manipulates child-sized scissors<br>**Pre-writing** – uses tripod grip while using a writing utensil | **Social interest** – actively interested in playing with familiar people<br>**Spontaneous play** – engages in spontaneous play<br>**Affection** – seeks out affection from primary caregiver as needed (e.g., a hug)<br>**Pride** – child shows expressions of pride when successful at an activity<br>**Pretend play** – engages in pretend play (e.g., uses blocks to represent food items, feeding a doll)<br>**Helping behaviours** – engaged in helping behaviours (e.g. clean up toys) | **Manipulating** – connects at least six pieces of a preschool level puzzle correctly<br>**Sorting** – sorts objects with one or more similar characteristic (e.g., similar colour)<br>**Number concepts –** numerical discrimination<br>**Problem solving –** identifies problems occurring during activities (e.g., “the block tower was too tall”)<br>**Memory –** able to recall at least three numbers in correct sequence |

| Age of the Child | Expressive and Receptive Language | Gross Motor | Fine Motor | Social-Emotional | Cognition |
|---|---|---|---|---|---|
| **40-42 Months**<br>*(40 months to 41 months and 30 days) [Continued]* | **Action verbs** – correctly describes the function of objects or the actions of people (e.g., "grandma eating")<br>**Causal Language** – can explain how simple cause and effect events occur (e.g., "cup spill, floor wet")<br>**Communicating** – uses at least 1000 words or signs<br>**Conjunctions** – uses simple transition words appropriately (e.g., "to/too", "because", "and", "but", "so", "or", "then")<br>**Asking** – regularly asks "why" to adults | | | **Self-regulation** – regulates response within 15 minutes (e.g., child may suck thumb, seek desired toy)<br>**Emotion labelling** – labels emotions of self and others<br>**Peer relations** – engages in acceptable play with other children<br>**Peer relations** – engages with one peer consistently<br>**Taking Turns** – begins taking turns with peers | |

| Age of the Child | Expressive and Receptive Language | Gross Motor | Fine Motor | Social-Emotional | Cognition |
|---|---|---|---|---|---|
| **42-44 Months** *(42 months to 43 months and 30 days)* | **Personal pronouns** – uses personal pronouns (e.g., "me", "my/mine" or "I")<br>**Understandable Speech** – speech can be understood by an adult at least 75% of the time<br>**Communicating** – verbalizes or signs first and last name<br>**Action verbs** – correctly describing the function of objects or the actions of people (e.g., "grandma eating")<br>**Causal Language** – can explain how simple cause and effect events occur (e.g., "cup spill, floor wet") | **Climbing** – ascends or descends stairs with limited support, alternating feet<br>**Standing** – briefly stand on one foot without support<br>**Throwing** – throws a ball a short distance forward, while standing in one place<br>**Jumping** – jumps forward and off the ground with two feet in place<br>**Catching** – opens arms and uses hands and chest to catch a large soft toy or ball | **Pre-writing** – draws a moderately round circle<br>**Grasping** – turns single pages of a book without help<br>**Cutting** – manipulates child-sized scissors<br>**Pre-writing** – uses tripod grip while using a writing utensil | **Social interest** – actively interested in playing with familiar people<br>**Spontaneous play** – engages in spontaneous play<br>**Affection** – seeks out affection from primary caregiver as needed (e.g., a hug)<br>**Pride** – child shows expressions of pride when successful at an activity<br>**Pretend play** – engages in pretend play (e.g., uses blocks to represent food items, feeding a doll)<br>**Helping behaviours** – engaged in helping behaviours (e.g. clean up toys) | **Number concepts –** numerical discrimination<br>**Problem solving –** identifies problems occurring during activities (e.g., "the block tower was too tall")<br>**Memory –** able to recall at least three numbers in correct sequence<br>**Size concepts –** understands the different between "big" and "small"<br>**Spatial concepts –** understands the difference between "over" and "under" |

| Age of the Child | Expressive and Receptive Language | Gross Motor | Fine Motor | Social-Emotional | Cognition |
|---|---|---|---|---|---|
| **42-44 Months**<br>*(42 months to 43 months and 30 days)*<br>*[Continued]* | **Communicating** – uses at least 1000 words or signs<br>**Conjunctions** – uses simple transition words appropriately (e.g., "to/too", "because", "and", "but", "so", "or", "then")<br>**Asking** – regularly asks "why" to adults<br>**Prepositions** – uses four prepositions in common language (e.g., "on", "under", "off", "in", "out")<br>**Pre-reading** – pretends to read (e.g., describes what is happening in picture books, oral retelling of a story previously heard) | | | **Self-regulation** – regulates response within 15 minutes (e.g., child may suck thumb, seek desired toy)<br>**Emotion labelling** – labels emotions of self and others<br>**Peer relations** – engages in acceptable play with other children<br>**Peer relations** – engages with one peer consistently<br>**Taking Turns** – begins taking turns with peers | |

| Age of the Child | Expressive and Receptive Language | Gross Motor | Fine Motor | Social-Emotional | Cognition |
|---|---|---|---|---|---|
| **42-44 Months** *(42 months to 43 months and 30 days) [Continued]* | **Descriptive language** – can describe features of an object, such as "the green ball" (e.g., colour shape) **Directions sequencing** – follows a sequence of directions (e.g., "take off your boots, remove your coat, then remove your snow pants) | | | | |

| Age of the Child | Expressive and Receptive Language | Gross Motor | Fine Motor | Social-Emotional | Cognition |
|---|---|---|---|---|---|
| **44-47 Months**<br>*(44 months to 46 months and 30 days)* | **Understandable Speech** – speech can be understood by an adult at least 75% of the time<br>**Causal Language** – can explain how simple cause and effect events occur (e.g., "cup spill, floor wet")<br>**Communicating** – uses at least 1000 words or signs<br>**Asking** – regularly asks "why" to adults<br>**Prepositions** – uses four prepositions in common language (e.g., "on", "under", "off", "in", "out")<br>**Pre-reading** – pretends to read (e.g., describes what is happening in picture books, oral retelling of a story previously heard) | **Jumping** – jumps forward and off the ground with two feet in place<br>**Catching** – opens arms and uses hands and chest to catch a large soft toy or ball<br>**Standing** – stands on one foot without support<br>**Throwing** – throws a ball forward, while standing in place (e.g., greater than 2 feet forward)<br>**Climbing** – climbs outdoor playground equipment without support<br>**Jumping** – jumps on one foot in place | **Cutting** – manipulates child-sized scissors<br>**Pre-writing** – uses tripod grip while using a writing utensil<br>**Pre-writing** – draws symbols that imitate letters or shapes | **Social interest** – actively interested in playing with familiar people<br>**Spontaneous play** – engages in spontaneous play<br>**Affection** – seeks out affection from primary caregiver as needed (e.g., a hug)<br>**Pride** – child shows expressions of pride when successful at an activity<br>**Pretend play** – engages in pretend play (e.g., uses blocks to represent food items, feeding a doll)<br>**Helping behaviours** – engaged in helping behaviours (e.g. clean up toys) | **Size concepts –** understands the different between "big" and "small"<br>**Spatial concepts –** understands the difference between "over" and "under"<br>**Numeracy –** uses one to one correspondence in everyday play<br>**Drawing –** draws a clear picture to represent a meaningful event or person<br>**Rhythm –** interprets the rhythm in music |

| Age of the Child | Expressive and Receptive Language | Gross Motor | Fine Motor | Social-Emotional | Cognition |
|---|---|---|---|---|---|
| **44-47 Months**<br>*(44 months to 46 months and 30 days)*<br>*[Continued]* | **Descriptive language** – can describe features of an object, such as "the green ball" (e.g., colour shape)<br>**Directions sequencing** – follows a sequence of directions (e.g., "take off your boots, remove your coat, then remove your snow pants)<br>**Pluralizing** – begins adding "s" and "es" to the end of words<br>**Communicating** – combines four words or signs into short phrases (e.g., "the baby is sleeping") | | | **Self-regulation** – regulates response within 15 minutes (e.g., child may suck thumb, seek desired toy)<br>**Emotion labelling** – labels emotions of self and others<br>**Peer relations** – engages in acceptable play with other children<br>**Peer relations** – engages with one peer consistently<br>**Taking Turns** – begins taking turns with peers | |

APPENDIX B. Instrument Comparison

| Instrument | Description | Application | Estimated Time of Completion | Psychometrics |
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| **Child Behaviour Checklist** | • The Achenbach System of Empirically Based Assessment (ASEBA) began development in the 1960's as a way to measure psychopathology (Achenbach & Rescorla, 2000).<br>• The *Child Behaviour Checklist* (CBCL), part of the ASEBA, is a highly valid and reliable instrument utilized to identify internalizing and externalizing disorders of children from 18 months to five years of age, and it relates to socio-emotional dysfunction based on the DSM-V criteria (Achenbach & Rescorla, 2000; Achenbach, 2014). | • The CBCL Preschool instrument is to be completed in approximately 10 minutes by parents and results are interpreted by trained professionals (Achenbach & Rescorla, 2000).<br>• *Items on the CBCL Preschool.* Items on the CBCL are scored based on the extent of problem behaviour (0= *not true*; 1= *somewhat or sometimes true*; 2= *for very true or often true*).<br>• Sample items from the CBCL include: *Gets too upset when separated from parents*; similarly measuring child-parent attachment style. Items for externalizing behaviour include, | 10-15 mins. | • Content validity is based on a definition of the constructs to be measured (AERA, APA & NCME, 2014). The content validity of the CBCL is based on expert reviewers, theoretical justification and iterations to the items on the instrument (Achenbach & Rescorla, 2000).<br>• Rather than measuring the CBCL against other well-known measures (Punch, 2009), the criterion-related validity was assessed by predicting referred and non-referred children based on a demographic sample of 563 children from various institutions of mental health. It was found that most all of the items on the preschool CBCL discriminated significantly ($p$<0.1).<br>• Lastly, stability over time measures to what extent an |

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| | | *Temper tantrums or hot temper*, as well as *Physically attacks people*. Internalizing symptoms are measured by characteristics such as, *Withdrawn, doesn't get involved with others*, or *Fears certain animals, situations, or places*. The main focus of the checklist is to ask about disruptive behaviour as well as inhibited behaviour and affect.<br>• The CBCL Preschool contain syndrome scales, including: emotionally reactive, anxious/depressed, somatic complaints, withdrawn, attention problems, aggressive behavior, and sleep problems. Items are also scored on the following DSM-oriented scales, which indicate problems in one area: affective, anxiety, pervasive developmental, attention | | assessment tool will find changes in scores if under the same circumstance (Punch, 2009). For the CBCL, test-retest reliability for the CBCL is strong (.85), however test attenuation revealed significant declines on the problem scales ($p$<.01). Test attenuation however, only accounted for 0.9% of the variance. |

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| | | deficit/hyperactivity, stress, autism spectrum, and oppositional defiant. | | |
| **Ages and Stages Questionnaire, Third Edition (ASQ-3)** | ▪ The ASQ-3 examines childhood development within five domains including, Problem-Solving, Communication, Personal-Social, and Fine and Gross Motor Movement and has uses items to assess childhood progression of specific milestones from 1 to 5.5 years of age (Bricker & Squires, 2009). | ▪ The ASQ-3 is to be completed by a primary caregiver and takes a maximum of 15 minutes to use. Scoring of the ASQ-3 should be done by an assessor. (Bricker & Squires, 2009).<br>▪ No standardized training is required.<br>▪ The items on the ASQ-3 use response format of, "most of the time", "sometimes", "rarely or never". On the ASQ-3, their 16-month questionnaire asks communication related questions such as, *When your child wants something, does she ask you by pointing to it?* Or gross motor related questions such as, *Does your child walk and seldom fall?* With regards to problem-solving, parents are | 15 mins. | ▪ The psychometric properties of the current ASQ-3 include a research sample of 15,138 children that reflect the current population of the United States (Bricker & Squires, 2009). Reported was the concurrent validity, as represented by measuring the ASQ-3 against professionally administered and standardized assessments, ranges from 74% – 100% on the various questionnaires, with 86% overall agreement. The sensitivity or ability to identify children with delays, ranges from 76% - 100%, with 86% overall agreement, and the ability to identify typically developing children, ranged from 70% – 100%, with 85% overall agreement (Bricker & Squires, 2009). |

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| | | asked, *Does your child drop several small toys, one after another into a container or box?* | | |
| **ASQ:SE-2** | ▪ The ASQ:SE-2 is designed to assess children from 1 to 72 months of age, to examine self-regulation, compliance, communication, adaptive behaviours, autonomy, affect and social interaction (Squires, Bricker & Twombly, 2015). | ▪ The ASQ:SE-2 is to be completed by a primary caregiver and takes a maximum of 15 minutes to use. Scoring should be done by an assessor.<br>▪ No standardized training is required.<br>▪ The items on the ASQ:SE-2 use response format of, "often or always", "sometimes", "rarely or never", and "check if this is a concern".<br>▪ On the ASQ:SE-2, a question measuring self-regulation includes, *When upset, can your child calm down within 15 minutes?* Affection is also measured by asking, *Does your child like to be hugged or cuddled?* With regards to assessing well-being, parents are asked simply, *Does your* | 15 mins. | ▪ The psychometric properties of the current ASQ:SE-2 are based on a sample size of 14,074 children at various age ranges.<br>▪ Concurrent validity was reported to be strong, at 83% overall.<br>▪ The internal consistency is reported at 84% using Cronbach's alpha.<br>▪ The test-retest reliability estimates are 89% (Squires, Bricker & Twombly, 2015). |

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| | | *child seem happy?* (Squires, Bricker & Twombly, 2015). | | |
| **Behaviour Assessment for Children, Third Edition (BASC-III)** | ▪ The Behaviour Assessment for Children, Third Edition (Reynolds, Kamphaus, 2015) is a teacher and parent rating scale assessing the behaviour and emotions of children and adolescents. The BASC-III measures for clinically significant scores, such as externalizing and internalizing problems, and behavioural symptoms. | ▪ The BASC-III for Children, parent form is to be completed in approximately 10- 20 minutes by parents and results are interpreted by trained professionals.<br>▪ Clinically oriented questions include, *has a short attention span, or disrupts other children's activities*. Other scales include adaptive skills, such as social skills and functional communication. Questions regarding children's adaptive skills include, *offers help to other children, or, is able to describe feeing accurately.* | 10-20 mins. | ▪ N/A |
| **Infant Toddler Social Emotional Assessment (ITSEA)** | • The Infant-Toddler Socio-Emotional Assessment (ITSEA, Carter, Briggs-Gowan, | ▪ This assessment is completed by parents and requires 30 minutes to complete. | 20-30 mins | ▪ The ITSEA was previously normed years prior to the current iteration, and further re-normed across a sample size of 1,235 children |

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| | 2006) was developed to assess childhood problem behaviours and social-emotional competencies for children between one to three years of age. | ▪ Scoring should be done by an assessor.<br>▪ No standardized training is required.<br>▪ Response to questions on the ITSEA include, "(0) Not true/rarely", "(1) Somewhat true/sometimes", and "(2) Very true/often". Sample items from the activity/impulsivity scale ITSEA are, Is constantly moving, or, Gets hurt so often you can't take your eyes off him/her. The peer aggression subscale items include, Teases other children, or, Hurts other children on purpose. | | between 12 and 36 months of age (Carter, Briggs-Gowan, 2006).<br>▪ Reported was the criterion validity based on the CBCL, The Infant Mullen Scales of Early Learning, Evaluator Ratings of Child Problems and Competencies, as well as parent ratings of temperament on the Colorodo Child Temperament Inventory and maternal distress on the Center for Epidemiologic Studies Depression Inventory and Beck Anxiety Inventory.<br>▪ Findings reveal that the ITSEA strongly measures childhood socio-emotional competence and internalizing and externalizing problems. The inter-rater reliability estimates for the domains were between 82% to 90% (Carter, Briggs-Gowan, 2006). |
| **Nipissing District Developmental Screen (NDDS)** | • The *Nipissing District Developmental Screen* (NDDS) is commonly used in Ontario and Provinces across Canada. It was developed to support the introduction of Healthy Babies Healthy Children | • The NDDS is to be completed in approximately 10 minutes by parents.<br>• Results are interpreted by the childcare professional.<br>• No standardized training is required. | 5-10 mins. | • The psychometric properties of this tool have yet to be fully reported. In a study done to examine the concurrent validity of the infant and toddler NDDSs, Dahinten and Ford compared findings from 118 children assessed with the *Bayley Scales of Infant Development-II* to the findings from the NDDS |

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| | on January 1, 1998 by the Government of Ontario (Dahinten & Ford, 2004).<br>• The purpose of its development was to support universal screening and healthy childhood development by assessing seven developmental categories as well as critical skills including vision and hearing (Dahinten & Ford, 2004).<br>• It provides a continuum of early assessment from one month to 6 years and can be completed by parents and professionals within minutes. | • *Items on the NDDS.* This tool is efficient, as it uses a one-flag rule (i.e. *yes, no* response format). Sample questions that pertain to development include, *By eighteen months, does your child hold a cup to drink?* Or, *By eighteen months, does your child follow directions using "on? and "under"?* | | (2004). Severe developmental delays were caught using the NDDS, however mild to moderate developmental concerns had low sensitivity rates. This prompts concerns over the applicability of the tool, as universal screeners are used with a wide population of children who may not otherwise be identified (Dahinten & Ford, 2004).<br>• In 2007, Cairney and Clinton also conducted a psychometric assessment of all 13 screens of the NDDS, with 812 parents in Ontario. Concurrent validity was established using the *Bayley Scales of Infant Development*, suggesting that the NDDS is sufficient at identifying children without a delay. Reliability and validity estimates are not presented. Authors made recommendations for this tool to be used in conjunction with other rigorous measures (Cairney & Clinton, 2007). |
| **Parents' Evaluations of Developmental Status** | • In line with the American Academy of Pediatrics, the *Parents' Evaluations of* | • The PEDS is to be completed in approximately 5-10 minutes by parents. | 5-10 minutes | ▪ The sensitivity of the PEDS by age and disabilities are 91% – 97% and 71% – 87%, respectively. The specificity of the PEDS falls |

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| | *Developmental Status* (PEDS: DM; Glascoe, 2013) is a parent-informed screening and surveillance tool that assesses the early academic skills, motor skills, language, social-emotional health and mental status of children birth to eight years.<br>• The PEDS: DM is specific to childhood development and includes the evaluation of physical, cognitive, social-emotional and language domains (Glascoe & Robertshaw, 2006).<br>• If the parental evaluation is flagged as demonstrating concern, parents are automatically directed to complete the more in-depth assessment and other potentially relevant subscales. Each tool has few questions and parents can choose to fill | • Results are interpreted by a professional.<br>• No standardized training is required.<br>• *Items on the PEDS and PEDS: Developmental Milestones.* The response format of the PEDS is "Yes", "No", and "A little". Questions are general, such as, *Do you have any concerns about how your child behaves with others?* Or, *Do you have any concerns about how your child talks and makes speech sounds?* The response format of the extended scales on the PEDS: DM vary depending on the question. The extended scales on the *PEDS: DM* asks questions such as, *When your child talks, how many words does he or she usually use at a time?* Or, *Can your child walk backwards two steps?* Parents may respond to one of three | | between 73% and 86% (Glascoe, 2013). To be used in conjunction, *PEDS: Developmental Milestones* (PEDS:DM, Glascoe & Robertshaw, 2006) was developed for screening and surveillance, with greater emphasis given to child mental health and developmental domains. Developmental milestones also change according to the age of the child. Unique to PEDS tools, cut offs are available for performance measures.<br>▪ Psychometrics for the PEDS:DM are similar, with strong levels of sensitivity by age (70% - 94%), performance on diagnostic measures (75% - 87%) and by disabilities (79% - 82%). Equally robust is the specificity by age (77% - 93%) and performance on diagnostic measures (71% - 88%). |

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| | in the items based on their knowledge. Alternatively, it can be administered to a child directly (Glascoe & Robertshaw, 2006; Glascoe, 2013). | options such as, "None", "1 – 2", or "3 or more".<br>• | | |
| **Bayley Scales of Infant and Toddler Development, Third edition** | • The Bayley Scales of Infant and Toddler Development, Third edition (Bayley-III; Bayley, 2006) assessed over 1,700 young children to gather normative data. The Bayley-III was developed to assess children aged 1 to 42 month on measures of cognition, communication, fine and gross motor development. It also includes two subscales examining social-emotional development and adaptive behaviour for parent completion (Bayley, 2006). | • This assessment is comprehensive and may need over an hour to complete. The Bayley-III also has a screening test that has been developed from the original measure, which requires up to 25 minutes to be administered. Those in the field of early childhood and special education, as well as school psychologists can administer both instruments (Bayley, 2006). | 25 mins | • The average reliability coefficients for each scale on the Bayley-III range from .91 to .93.<br>• Also relatively stable are the reliability coefficients at .80 or higher across all age groups (Bayley, 2006).<br>• Authors state that their instrument can discriminate between clinical and non-clinical cases.<br>• The Bayley-III is a well used as an assessment of childhood development, however it tends to overestimate development and thus, poorly identify children with high developmental risk (Anderson et al., 2010). Authors of the instrument claim that the Bayley-III is experiencing the "Flynn Effect", whereby intelligence scores increase over time, but they |

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| | | | | acknowledge that the Bayley-III does not entirely measure early childhood intelligence (Bayley, 2006). |

APPENDIX C. REB Approval Notice

Western Research

Research Ethics

**Western University Non-Medical Research Ethics Board**
**NMREB Full Board Initial Approval Notice**

**Principal Investigator**: Dr. Shannon Stewart
**Department & Institution**: Education\Faculty of Education,Western University

**NMREB File Number**: 108024
**Study Title**: Constructing and Validating the interRAI 0-3 for the Developmental and Mental Health Needs of Children and Families

**NMREB Initial Approval Date**: September 26, 2016
**NMREB Expiry Date**: September 26, 2017

**Documents Approved and/or Received for Information**:

| Document Name | Comments | Version Date |
|---|---|---|
| Western University Protocol | Received August 3, 2016 | |
| Recruitment Items | Verbal Script Assessors | 2016/06/15 |
| Letter of Information & Consent | V5_Clean Copy_ Consent Form_Assessors for Research | 2016/08/24 |
| Recruitment Items | Verbal Script Families | 2016/06/15 |
| Caregiver Letter of Information & Consent | V5_Clean Copy_Guardian Consent Research | 2016/08/24 |
| Instruments | interRAI 0-3 Assessment Form | 2016/05/24 |
| Instruments | Brief Follow Up Questionnaire - Assessors; Feedback Form - Assessors *Received May 24, 2016 | |
| Other | interRAI 0-3 Manual - Received for Information May 25, 2016 | |

The Western University Non-Medical Research Ethics Board (NMREB) has reviewed and approved the above named study, as of the NMREB Initial Approval Date noted above.

NMREB approval for this study remains valid until the NMREB Expiry Date noted above, conditional to timely submission and acceptance of NMREB Continuing Ethics Review.

The Western University NMREB operates in compliance with the Tri-Council Policy Statement Ethical Conduct for Research Involving Humans (TCPS2), the Ontario Personal Health Information Protection Act (PHIPA, 2004), and the applicable laws and regulations of Ontario.

Members of the NMREB who are named as Investigators in research studies do not participate in discussions related to, nor vote on such studies when they are presented to the REB.

The NMREB is registered with the U.S. Department of Health & Human Services under the IRB registration number IRB 00000941.

APPENDIX D. Curriculum Vitae

# JO ANN IANTOSCA

PhD, MEd, BEd, HBA

## EDUCATION

**PhD Candidate, Education Studies, Applied Psychology** 2012 – 2020
The University of Western Ontario, London, ON
Dissertation: Construction and Preliminary Validation of the interRAI 0-3 Developmental Domains
Advisor: Dr. Shannon Stewart

**Masters of Education** 2010 – 2012
University of Windsor, Windsor, ON
Thesis: *Uniting Early Screening and Monitoring to Inform Intervention Practices*
Advisor: Dr. Dragana Martinovic

**Concurrent Education Program** 2004 – 2009

**Bachelor of Education, Primary/Junior**
University of Windsor, Windsor, ON

**Honours Developmental Psychology,** Minor: Sociology; Minor: Dramatic Arts
University of Windsor, Windsor, ON

**Diploma Early Childhood Education**
St. Clair College, Windsor, ON

## PROFESSIONAL STATUS

Ontario Certified Teacher # 538357 2009 – Present

Registered Early Childhood Educator #29225 2009 – Present

## SCHOLARSHIPS, AWARDS AND DISTINCTIONS

Poverty Reduction Grant of Ontario ($470, 000)- Co-investigator 2015
*University of Western Ontario*

London Community Vitality Grant ($167, 000)- Co-investigator 2015
*University of Western Ontario*

Mitacs Research Grant ($15, 000) - Primary Investigator 2012
*University of Western Ontario*

Western Graduate Research Scholarship ($18,000/year) 2012 – 2016
*University of Western Ontario*

Gregory Blake Nephew Memorial Scholarship ($500) 2011
*University of Windsor*

Internal Scholarship ($1,000) 2004, 2005
*University of Windsor*

## TEACHING AND RELATED EXPERIENCE

**Full-time Teaching:**

As Professor at Seneca College, my teaching responsibilities include preparing and giving weekly lectures, developing course assignments and examinations, meeting with students, and submitting final grades to the Office of the Registrar. As a Professor, I have also supported ongoing PEQAB and program review, presented at multiple academic forums, and engage in consultation with community partners. I continue to conduct research by obtaining municipal, provincial and federal grant opportunities. I have also undertaken supervision of 40 undergraduate thesis in addition to my teaching and administrative duties.

**Professor,** Seneca College, Toronto, ON
School of Early Childhood Education, Bachelor of Child Development
September 2015 – Present

Courses taught in Degree Program: BCD304 Children with Special Needs; EAD308 Historical and Philosophical Traditions in ECE; BCD708 Early Identification: Screening and Assessment; BCD606 Introduction to Research Methods; BCD706 Applied Research Proposal; BCD806 Applied Research Paper.

Courses taught in Diploma Program: ECE414 Children with Exceptionalities; ECE409 Historical and Philosophical Traditions in ECE.

**Part-time and Sessional Teaching:**

As a sessional and part-time professor, teaching in both Degree and Diploma Programs, my responsibilities have included preparing and giving weekly lectures, developing course assignments and examinations, meeting with students, supervising and evaluating course placements, and submitting final grades to the Office of the Registrar.

**Sessional Professor,** Fanshawe College, London, ON
School of Human Services, Bachelor of Applied Arts program
January 2013 – August 2014

Courses taught in Degree Program: ECED 7001 Evidence-Based Practice; ECED 7016 Human Development Current Topics; ECED 7017 Curriculum for Early Learning; ECED 7018 ECE Program & System Delivery; ECED 7007 Social & Physical Environment

Courses taught in Diploma Program: ECED 1003 Health, Safety & Nutrition; ECED 1034 Advocacy & Bias Free Practice; ECED 1050 Child Development I; ECED 3018 Inclusion-Issues & Implementation

**Part-time Instructor,** St. Clair College, Windsor, ON
School of Community Studies, Early Childhood Education Program
September 2010 – April 2012

Courses taught: ECE106 Field Placement I; ECE122 Preschool Development and Best Practice; ECE130 Child Development I; ECE230 Child Development II; ECE216 Field Placement II; ECE312 Children with Diverse Abilities; ECE310 Infant/Toddler Learning Environment; ECE313 Field Placement III; ECE408 Child Development III: Assessment and Inclusion

**Teaching & Graduate Assistantships:**

As a teaching assistant, my responsibilities have included preparing and leading lectures, grading student assessments, meeting with students, and proctoring and evaluating exams. As graduate assistant, my responsibilities have included transcribing data, conducting literature reviews, constructing and validating an instrument, manual and software system, project coordination, leading various committees, and training assessors on screening tools.

**Graduate Research Assistant,** Faculty of Education, University of Western Ontario
September 2012 - 2016

**Graduate Assistant**, Faculty of Education, University of Windsor, Windsor ON
September 2010 – April 2011 & January 2012 – April 2012

**Teaching Assistant**, Department of Psychology, University of Windsor, Windsor, ON
January 2008 – April 2008

**Secondary, Elementary, and Early Childhood Education:**

As an elementary occasional teacher in various short-term positions, and full-time early childhood educator, my responsibilities have included preparing and teaching lessons and activity plans, supporting challenging behaviour of children with Autism Spectrum Disorder, meeting with families from diverse cultures, developing individual program plans, and providing workshops. As a scorer, my responsibilities have included scoring standardized testing for a grade 10 English opinion piece, including students with English as their second language.

**Occasional Teacher,** Lambton-Kent District School Board, Chatham, ON
March 2010 – August 2014

**Occasional Teacher,** St. Clair Catholic District School Board, Chatham, ON
April 2010 – December 2015

**Early Childhood Educator (FT),** New Canadian Centre of Excellence, Windsor, ON
2009 - 2010

**Scorer,** Education Quality and Accountability Office (EQAO), Toronto, ON
May 2009

**Coordination and Proctoring:**

As a proctor, my responsibilities have included monitoring students, supporting testing services in Student Disability Services, and setting up Kurzweil, Dragon and CTV equipment as accommodations for students. As a coordinator within the same department, my responsibilities have included coordinating and managing a summer program for new university students, preparing events and presentations, assisting students in developing new skills/knowledge about learning disabilities, and referring students to various on and off campus resources.

**Proctor,** Student Disability Services, University of Windsor, Windsor, ON
January 2007 – April 2009

**BUILD Program Coordinator,** Bridge to University for Individuals with Learning Disabilities, University of Windsor, ON
Summer 2008

**INVITED LECTURES**

**Iantosca** J.M. (2018). *Development of the interRAI 0-3*. inSPIRe Brisbane Masterclass. Princess Alexandra Hospital, Brisbane, Australia, November 2018.

**Iantosca** J.M., Peters, J., Yazdani M. (2017) *Digital Storytelling.* Teaching and Learning with Technology Day. Seneca College, Toronto, ON, May 2017.

**Stewart, S.,** Iantosca, J. M. (2017). *At risk children: How early intervention can lead to future success.* Let's Talk about Education, Community Speaker Series, The University of Western Ontario, London, ON, January 2017.

**Iantosca**, J. M. (2015). *What are they trying to tell us: Understanding Mental Health in the Early Years*. Mental Health Literacy Day, The University of Western Ontario, London, ON, February 2015.

**Iantosca**, J. M. (2012). *Don't lock the Tupperware cupboard*. Beating the Winter Blues

Conference. St. Clair College, Windsor, ON, February 2012.

## ADDITIONAL RESEARCH EXPERIENCE

**Research Assistant,** The Effect of Embedded Pictures on Sight Words Acquisition
Stanford University
September 2012 – December 2012

- Coordinated data collection and recorded collected student data
- Reported on experimental and control group findings

**MITACS Research Internship**, MITACS, Toronto, ON
January 2013 – October 2013

- Worked with a technology team to assess childhood videos for content themes
- Recruited participants and designed a survey to assess children's learning from videos
- Conducted a thorough literature search and developed a manuscript for publication on the cognition of childhood media
- Presented research at a national conference on early childhood education

## PUBLICATIONS

Stewart S. L., **Iantosca**, J. M., Klassen, J., Tucker, M., Fisman, S., McClean, J. (2019) interRAI 0-3 Assessment Form and User's Manual. Version 1. Washington, DC: interRAI.

Asare-Bediako, Y., **Iantosca**, J. M., Stewart, S. L., Romanson, A., Price, A., Martin, L., & Gardiner, J. Communication. In Stewart, S. L. et al. interRAI (CAPs) for use with the interRAI 0-3 Assessment Instrument, Research Version 1 Standard Edition. Washington, DC: interRAI.

Thornley, E., Stewart, S. L., **Iantosca**, J. M. Emotional Regulation. In Stewart, S. L. et al. interRAI (CAPs) for use with the interRAI 0-3 Assessment Instrument, Research Version 1 Standard Edition. Washington, DC: interRAI.

Thornley, E., Stewart, S. L., **Iantosca**, J.M. Sociability. In Stewart, S. L. et al. interRAI (CAPs) for use with the interRAI 0-3 Assessment Instrument, Research Version 1 Standard Edition. Washington, DC: interRAI.

Asare-Bediako, Y., Cloutier, S. E., **Iantosca**, J. M., Stewart, S. L., Theall, L., Swart, G. T., Rovis, K., Matthias, K., & McLean, J. Dressing. In Stewart, S. L. et al. interRAI (CAPs) for use with the interRAI 0-3 Assessment Instrument, Research Version 1 Standard Edition. Washington, DC: interRAI.

Stewart, S., & **Iantosca, J. A.** (2016). The interRAI 0-3: Assessing individual differences in temperament, early childhood mental health and development. *Personality and Individual Differences, 101,* 517-518. doi:10.1016/j.paid.2016.05.310

**Iantosca,** J. M. (2016). One step forward and baby steps back. *Canadian Childcare Federation: Multibriefs Exclusive*. Retrieved from: http://exclusive.multibriefs.com/content/one-step-forward-and-baby-steps-back/education

**Iantosca**, J. M. (2014). Screentime is here to stay: Associations between watching pro-social content and preschool socio-emotional development. *Canadian Society for Studies in Education Conference Abstract*. May, 2014. Retrieved from: http://app.core-apps.com/csse2014/abstract/951c8da69bf5ea1f20ccd9f3bb2da665.

**Iantosca**, J. M. (2013). Canadian Association of School Psychologists Newsletter. *Canadian Association of School Psychologists*. January, 2013, p. 13. Retrieved from http://www.cpa.ca/CASP/newsletter/2013_Winter_EDnewsletter.pdf.

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**Iantosca,** J. M., Klassen, J., Stewart, S. (2017). The interRAI 0-3: Using a Comprehensive Measurement System to Identify and Intervene on the Needs of Young Children. International Society for Child Indicators. Montreal, Quebec, June, 2017.

**Iantosca,** J. M., Stewart, S. (2016). Constructing and Validating the interRAI 0-3. Oral Presentation at interRAI World Conference. Toronto, ON, April 2016.

**Iantosca**, J. M., Stewart, S. (2015). For their Future Wellness: *Using the interRAI 0-3 to Assess Early Childhood Mental Health and Development.* Oral Presentation at National Training Institute, Zero to Three. Seattle, WA, December, 2015.

**Iantosca**, J. M., Stewart, S. & Tucker, M. (2015). *Using the interRAI 0-3 to Assess Early Childhood Mental Health and Development.* Workshop at Better Together: Collaborating for a Stronger Child & Youth Mental Health System 2015 CMHO Conference. The Marriott Toronto Downtown Eaton Centre, November, 2015.

Stewart, S. & **Iantosca**, J. M. (2015). *The interRAI 0-3: Assessing individual differences in temperament, early childhood mental health and development.* Oral Presentation at The International Society for the Study of Individual Differences Conference. The University of Western Ontario, July, 2015.

**Iantosca**, J. M. (2015). *Education status of children with developmental disabilities: Psychosocial well being and resilience*. Roundtable Presentation at the Canadian Society for Studies in Education. Ottawa, ON, June, 2015.

Stewart, S. & **Iantosca**, J. M. (2015). *Construction of the interRAI 0-3 to assess early childhood mental health and development.* Oral Presentation at the Child Health Symposium. The University of Western Ontario, May, 2015

**Iantosca**, J. M. (2014). *Screentime is here to stay: Associations between watching pro-social content and preschool socio-emotional development*. Round table presentation at the Canadian Society for Studies in Education. St. Catherine's, ON, May, 2014.

**Iantosca**, J. M. (2013). *Screentime is here to stay: Associations between watching pro-social content and preschool socio-emotional development*. Poster presentation at the National Association for the Education of Young Children Conference. Washington, DC, November, 2013.

**Iantosca**, J. M. (2013). *Uniting early childhood screening and monitoring to inform intervention practices*. Poster presentation at Canadian Psychological Association Conference. Quebec, QC, July 2013.

## NON-REFEREED CONFERENCES

**Iantosca**, J. M. (2015). *Construction of the interRAI 0-3 to assess early childhood mental health and development.* Oral presentation at the Robert Macmillian Graduate Research in Education Symposium. The University of Western Ontario, March 2015

**Iantosca**, J. M. (2013). *Uniting early childhood screening and monitoring to inform intervention practices*. Poster presentation at the Robert Macmillian Graduate Research in Education Symposium. The University of Western Ontario, March 2013.

**Iantosca**, J. M. (2011). *Using the ELECT in early childhood education: Creating methods for more efficient screening practice*. Poster presentation at Bringing Communities Together Conference. University of Windsor, ON, March 2011.

## ACADEMIC SERVICE AND LEADERSHIP

**Academic Consultant,** BeMo Academic Consulting, Toronto, ON
October 2014 – November 2017

- Provide professional editing services for prospective applicants to law school, medical school and graduate school
- Deliver webinars and interview practice for medical student candidates

**Graduate Representative,** Canadian Association for Educational Psychology (CAEP)
May 2015 – May 2016

- Supported development and edited the CAEP Dialogic
- Led outreach to multiple universities regarding CSSE conference

**Peer Reviewer,** Journal of Early Childhood Research
March 2015 – Present

- Review journals pertaining to childhood mental health; technology; assessment and curriculum
- Review qualitative and quantitative journals pertaining to childhood research

- Provide feedback and recommendations to the editor about acceptance and revisions of the submitted manuscripts

**Co-Chair 0-3 interRAI Coordinating Committee**, University of Western Ontario
December 2014 – Present
- Collaborated with an expert panel to direct initiatives on the development of the interRAI 0-3 instrument

**Peer Reviewer,** Journal of Early Childhood Intervention
March 2013 – Present
- Review journals pertaining to childhood intervention, development, and assessment
- Provide feedback and recommendations to the editor about acceptance and revisions of the submitted manuscripts

**Peer Reviewer**, Canadian Society for Studies in Education (CSSE)
May 2013, May 2014
- Review and provide feedback and recommendations to the editor and applicants of the CSSE conference

**Academic Chair, ELECT,** Society of Graduate Students, University of Western Ontario
September 2012 – 2014
- Built on the strengths of the committee by assigning appropriate roles while organizing a university wide graduate conference
- Supported decision making on graduate scholarships
- Ensured that all tasks were completed in a timely manner