

University of Alberta

The Relationship Between Early Cognitive Development and Adolescent
Depression

by

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ABSTRACT

Worldwide, depression is the leading cause of disability. However, its etiology is not yet fully understood. The current research investigated the relationship between early cognitive development and adolescent depression. Two studies were conducted using data from a prospective longitudinal cohort study conducted by Statistics Canada since 1994/1995, the National Longitudinal Survey of Children and Youth. The first study investigated whether impaired early cognitive development was related to adolescent symptoms of depression and anxiety. The second study investigated whether individuals with impaired early cognitive development were more likely to suffer from depressive and anxious symptoms after considering stressful life events in adolescence (using interaction models). Our results suggest that early cognitive development may be related to the development of depression and anxiety in adolescence. However, no interaction was found between impaired early cognitive development and stressful life events. These results suggest that cognitive deficits may precede the onset of adolescent depression.

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Possible mechanism for adolescent depression.

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List of Abbreviations

DSM-IV-TR: Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition, Text Revision

LICO: Low Income Cut Off

MSD: Motor and Social Development

NLSCY: National Longitudinal Survey of Children and Youth

PMK: Person Most Knowledgeable

PPVT-R: Peabody Picture Vocabulary Test Revised

SES: Socioeconomic Status

CHAPTER 1.0 INTRODUCTION

1.1 BACKGROUND

1.1.1 Epidemiology of Depression

Worldwide, depression is the leading cause of disability and the seventh leading contributor to the burden of disease.¹ A nationally representative survey of 9,282 adults in the United States estimated the lifetime prevalence of major depressive disorder to be 16.6%.² Results from the same survey estimated the one year prevalence of major depressive disorder to be 6.7%.³ The median age of onset of major depressive disorder is 32, but onset can occur at any time in the life course.² Younger age of onset of major depressive disorder is associated with more severe and recurrent symptoms of depression and greater functional impairment.⁴ Depression is more common in women. A study of 72,933 adults across 15 countries found that women, compared to men, have 90% higher odds of developing major depressive disorder.⁵ Despite the high prevalence of depression, its causes and the relationship among causal factors remain unclear.

1.1.2 Adolescent Depression

Among adolescents, the six and twelve month prevalence estimates of major depressive disorders range from 2.5% to 13.3%.⁶ Adolescent depression is associated with a host of consequences in adulthood such as marital dissatisfaction,⁷ lower educational attainment,⁸ obesity,⁹ persistent interpersonal difficulties,¹⁰ suicidality¹⁰ and increased risk of future anxiety and depression episodes.^{11,12} Due to the risks associated with adolescent depression, it is

particularly important from a public health perspective to study early associations with this condition in an attempt to inform policy and design early interventions.

1.1.3 Diagnosis of Depression

1.1.3.1 Major depressive disorder

Clinically, major depressive disorder is defined by the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV-TR) as one or more major depressive episodes. A major depressive episode is a period of two weeks or more in which an individual experiences depressed mood and/or anhedonia resulting in significant functional impairment.¹³ Additional symptoms can include changes in weight or appetite, changes in sleep, psychomotor agitation or retardation, decreased energy, feelings of worthlessness or inappropriate guilt, decreased concentration as well as suicidal ideation and attempts.¹³ The diagnosis of a major depressive episode cannot be made when bereavement better accounts for the symptoms or when a major depressive episode occurs secondary to a substance use problem (e.g. alcohol) or a general medical condition (e.g. hypothyroidism).¹³ A review indicated that 15.9-61.9% of children and adolescents identified as being anxious or depressed had a comorbid depressive or anxious disorder.¹⁴ Additionally, measures of anxiety and depression were highly correlated.¹⁴

1.1.3.2 Categorical VS Continuum

Recent research has shown that depression may be better conceptualized along a continuum (from minor depressive symptoms to severe depressive symptoms)

than as a categorical diagnosis.¹⁵ Subthreshold depression has been defined as having two or more depressive symptoms simultaneously for at least two weeks, with symptoms occurring most or all of the time, causing social dysfunction, but not meeting diagnostic criteria for depression.¹⁶ Subthreshold depressive disorders occur worldwide,¹⁵ have been shown to impair quality of life,¹⁷ impair daily activities,¹⁸ and produce decrements in health.¹⁵ Furthermore, symptoms show improvement when treated with selective serotonin reuptake inhibitors.¹⁹ Subthreshold disorders lie on a spectrum with more severe depressive episodes but are different from typical fluctuations in mood.¹⁵ It has been suggested that the use of a categorical diagnostic system for a disease that exists on a continuum may misrepresent the true underlying spectrum of depression.²⁰

1.1.4 Stress Diathesis Model

The dominating explanatory model for depression is the stress diathesis model. The model assumes that some individuals are more vulnerable to depression than others. After experiencing stressful life events, these individuals are more likely to experience depression.⁶ Studies have demonstrated that there is a relationship between stressful life events and depression.^{21, 22} However, stressful life events do not inevitably lead to the development of depression.

One of the most well-known stress-diathesis models in depression research is a gene- environment interaction. Those carrying the s/s allele of the 5HTTLPR gene appear to be more likely to become depressed after the occurrence of stressful life

events.²³ Specifically, a prospective longitudinal cohort study found that those with a functional polymorphism in the promoter region of the serotonin transporter gene were more likely to experience elevated depressive symptoms, have diagnosable depression and be suicidal after the occurrence of stressful life events. This provides evidence for a possible gene by environment interaction in relation to the development of depression.

Several potential cognitive vulnerability factors have been investigated in relation to the stress diathesis model. Adolescents with dysfunctional attitudes (having a negative inferential style about self, causes and consequences) are more likely to become depressed after the occurrence of stressful life events.²⁴ Seventh graders with higher levels of self-criticism have increased levels of depressive symptoms following a stressful event related to negative achievements, but not stressful interpersonal events.²⁵ A study using the 1946 British birth cohort found higher childhood cognitive ability was associated with fewer depressive and anxious symptoms in adult women.²⁶ The authors suggested that those with lower cognitive ability may have poorer coping mechanisms to deal with stressful life events than those with higher cognitive ability making them more susceptible to depressive symptoms.²⁶ They suggested this relationship may be gender specific and higher cognitive ability may provide a source of resilience to stressful circumstances which has more benefit to women.

A recent review of depression research illustrated that causation of depression is evidently multifactorial with many different causal factors interacting over time.²⁷ Investigating vulnerabilities and interactions among causal factors across the life course is important for understanding the etiology of depression.²⁷

1.1.5 Cognitive Theory of Depression

The main assumption underlying cognitive models of depression is that specific cognitive processes are associated with the onset and experience of depression.²⁸

A vast amount of theory and research has accumulated, guided by a cognitive model for depression.²⁹⁻³³ The following section will discuss an influential cognitive theory in depression research.

1.1.5.1 Beck's Cognitive Theory of Depression

Beck's Cognitive Model of Depression is perhaps the most influential cognitive theory in depression research. Williams³⁴ identifies three main components to Beck's cognitive theory of depression.³⁵ The first component is having negative automatic thoughts. The person has thoughts that are unprompted by their actual current situation and based on insufficient reasoning. They are quick to accept these thoughts, which provoke further negative thinking and cause the person to sink deeper and deeper into a series of negative thoughts. The person holds negative views of themselves, others and the future. The second major component outlined by Williams³⁴ is the presence of systematic errors in information processing. Some examples of these errors include "selective abstraction," where

an individual focuses on a small unrepresentative detail and extrapolates to a larger picture. Another example is called “arbitrary inference,” which refers to the formation of a conclusion based on insufficient information. Additionally, “overgeneralization” consists of coming to general conclusions based on only specific situations. The third component is the presence of depressogenic schemata. In broad terms, Beck³⁶ defined the schema as a cognitive structure responsible for screening, coding and organizing incoming information. Depressogenic schemata are latent until activated by certain stressors. Once they become activated, the affected person becomes depressed.³⁵

Central to this theory is the concept that differences in individuals’ cognitive processes lead to differences in mental health outcomes. This leads us to question how cognitive development might differ between healthy individuals and those who become depressed.

1.1.6 Cognitive Impairment In Depression

In this section, the three main domains of cognition impaired in depression will be reviewed:

1. Memory
2. Executive Functioning
3. Attention

The research that has been done in this area will be outlined and the point will be made that there is a lack of evidence in this area for whether cognitive impairment

precedes or co-occurs with depression onset. The majority of studies in this area have looked at individuals considered at high risk for developing depression prior to the onset of depression. However, the lack of prospective studies in this area makes any evidence very weak. Additionally, results of the outlined studies vary widely in their findings. There is a lack of evidence as to whether cognitive impairment precedes or co-occurs with depression and prospective studies are needed in this area.

1.1.6.1 Impairment in Memory Function:

A large number of studies have found an association between memory impairment and depression.³⁷⁻⁴⁰ Additionally, several meta-analyses have confirmed there is a significant association between depression and memory impairment.^{41, 42} A recent meta-analysis found a significant relationship between depression and episodic memory (memory for events⁴³), but did not find an association between depression and semantic memory (memory for facts⁴³) or visuo-spatial memory (memory for visual stimuli⁴³).⁴²

There is some question as to whether these memory cognitive deficits in depression co-occur with the illness or are present prior to onset of depression. Some research suggests that the memory deficits observed in depressed patients are transient and do not represent underlying neurological deficits.⁴⁴ However, many study results suggest the contrary. A recent study compared subjects with remitted major depressive disorder with healthy controls. The study found that the

remitted depression subjects had higher deficits in non-verbal memory.⁴⁵ Similarly, a separate study found that symptom-free patients with recurrent depressive disorder were significantly impaired in immediate visual memory, delayed logical and visual memory, paired learning and block design compared to healthy controls.⁴⁶ In another study, remitted major depressive disorder patients were found to have impaired spatial working memory compared to healthy controls.⁴⁷ In a sample of elderly depressed patients, after recovery from depression, memory and learning were impaired compared to healthy controls.⁴⁸ These results suggest that some cognitive deficits remain after recovery from depression. However, without a prospective study, evidence for temporality is weak.

Additionally, there is some evidence that cognitive impairment precedes the onset of clinical depression.⁴⁹ A recent study looked at young women (aged 16-21 years) who had a family history of depression, but had never experienced depression. These women were considered at risk for developing depression. These at risk subjects were found to have impaired memory in comparison with controls (who did not have a family history of depression). The authors suggested that some of the cognitive dysfunction observed in depressed populations may precede the onset of illness.⁴⁹ In contrast, a different study found no memory deficits in adolescents with a family history of major depressive disorder compared with healthy controls.⁵⁰ There are conflicting results in this area and

further research, in particular prospective cohort studies are needed to determine whether memory deficits precede the onset of depression.

There is a paucity of research investigating potential cognitive deficits prior to the onset of depressive symptoms. Although many of the aforementioned studies suggest that cognitive deficits may be present prior to the onset of depression, without studies which are prospective in design it is not possible to draw firm conclusions about the temporal nature of these deficits.

1.1.6.2 Impairment in Executive Function:

Executive function consists of a wide array of neuropsychological functions including (but not limited to) set shifting, set maintenance, planning and spatio-temporal integration.⁵¹ Many studies have demonstrated an association between executive functioning and depression.⁵²⁻⁵⁶ Similar to the data regarding memory, there has been debate as to whether deficits in executive functioning precede the onset or co-occur with depression. A study of patients suffering from major unipolar depression demonstrated that measures of executive function no longer differed from healthy controls after complete recovery from depression.⁵⁷

Similarly, antidepressant treatment for depressed patients has been shown to have a beneficial effect on their executive functioning.⁵⁸ In contrast, a separate study showed that euthymic patients with major depressive disorder showed deficits in tests related to executive functions in comparison with healthy controls.⁵⁹

To the best of our knowledge, only two studies have attempted to assess whether deficits in executive function precede the onset of depression. The first study, conducted by Klimes-Dougan et al. (2006), assessed executive functioning of the adolescent (age 13-18 years) offspring of mothers with major depressive disorder.⁵⁰ These adolescents were considered at risk for developing depression. The study did not find deficits in executive function in children of mothers with major depressive disorder in comparison with controls.⁵⁰ A second study by Micco et al. (2009) studied children (ages 6-17 years) of parents with major depression and/or panic disorder and found similar results. Parental major depressive disorder was not associated with neuropsychological impairments preceding illness.⁶⁰ These two studies may suggest that the observed deficits in executive functioning do not precede the onset of depression. However, there is little research in this area, and the lack of prospective studies prevent the ability to draw conclusions about the temporal nature of these deficits. Further studies using a prospective design are needed in this area.

1.1.6.3 Impaired Attention:

Several studies have associated impaired attention with depression.⁶¹⁻⁶³ Again, it is uncertain whether these deficits in attention precede the onset of depression.

One study did not find any deficits in sustained attention among remitted depressed patients.⁶⁴ Acutely depressed patients showed an attentional bias towards negative information, but this bias was not seen among partially remitted patients.⁶⁵ In contrast to these results, another study found that formerly

depressed subjects showed an attentional bias towards sad emotional faces in comparison with healthy controls.⁶⁶ The results in this research area are inconsistent. It is therefore not clear whether cognitive processes relating to attention of remitted depressed individuals differ from healthy individuals.

One study attempted to assess whether deficits in attention exist prior to the onset of depression. Klimes-Dougan et al. (2006) assessed attention among adolescent offspring of mothers with major depressive disorder.⁵⁰ These adolescents were considered at risk for developing depression. The study did not find deficits in attention in offspring of mothers with major depressive disorder compared to controls.⁵⁰ The results in this area are not consistent and thus it is not clear whether the observed attentional deficits precede the onset of depression. Additionally, prospective studies would be needed to draw any conclusions about the temporality of this relationship.

1.1.7 Measures of Cognitive Ability and Depression

1.1.7.1 Intelligence Tests

Premorbid IQ score is associated with mental health outcomes.⁶⁷ Specifically, in a longitudinal study of Swedish conscripts who were 18-20 years old, lower IQ scores upon entry into the army were associated with increased risk for developing severe depression later in life.⁶⁷ The same association exists for childhood IQ scores. A study of a New Zealand birth cohort followed to age 32 by Koenen et al. (2009) found that lower childhood IQ was associated with an

increased risk of developing adult depression, as well as adult anxiety and schizophrenia spectrum disorder.⁶⁸ Similarly, it was found in a British birth cohort that higher childhood IQ was associated with fewer internalizing symptoms of depression and anxiety at age 53.²⁶

However, in a recent study of childhood IQ and adolescent mental health, the relationship between IQ scores and depressive symptoms varied according to age and/or pubertal stage.⁶⁹ Specifically, IQ scores at the age of 8 were inversely associated with depressive symptoms at age 11. However, a higher IQ at the age of 8 was associated with a higher risk of depressive symptoms at ages 13-14.⁶⁹ At age 17, this relationship lessened for females and in some analyses even returned to being an inverse association. However, in males, a higher IQ at age 8 continued to predict higher depression at age 17.⁶⁹ The authors speculated that the results may be explained by three previously reported associations. First, higher cognitive ability has been linked to early puberty. Second, puberty is accompanied by an increased prevalence of affective disorders. Third, higher cognitive ability is linked to decreased depressive symptoms. Hence, an earlier entry into puberty among individuals with higher cognitive ability could mask the protective effects of cognitive ability against depression until the end of puberty.⁶⁹

1.1.7.2 Academic Performance

Depression is associated with poor academic performance.⁷⁰⁻⁷² A prospective longitudinal study found that poor school performance in childhood was

associated with depressive disorders in adulthood.⁷³ Another study found that poor academic achievement in girls at age 9 was associated with major depression in adulthood.⁷⁴ However, this relationship was not found in males.⁷⁴ Poor academic performance in childhood predicts increased mental health service use in early adulthood.⁷⁵ In a two year longitudinal study of elementary school children, poor academic performance was a significant predictor of depressive symptoms.⁷⁶ Interestingly, this effect did not hold for children who had numerous friends.⁷⁶ Additionally, adolescents who suffer from depression are less likely to have graduated from higher education by age 30 than non-depressed adolescents.⁷⁷ It has been suggested that anxious and depressive symptoms may be associated with deficits in working memory, which in turn may lead to poor academic performance.⁷⁸

1.1.7.3 Reading Ability

Reading ability is closely linked to academic performance. Deficits in reading ability are associated with depression.⁷⁹⁻⁸³ A longitudinal study of boys attending public school in Pittsburgh (initially in grades 1, 4 and 7) found that severe persistent reading problems in boys who were ages 7 and 10 years were associated with concurrent elevated depressive symptoms. However, the same relationship was not found in boys who had already entered their teens.⁷⁹ In a study of school-aged twins (mean age 10.7), reading disability was associated with symptoms of anxiety and depression. This relationship remained significant after controlling for comorbid ADHD.⁸⁰ In a study of sixth grade children, level of depression was

found to be inversely associated with teacher-rated current reading level as well as reading achievement (represented by a standardized test score, the California Achievement Test).⁸¹ Similarly, a study of Norwegian adolescents found reading difficulties were associated with higher levels of depressive symptoms.⁸³

However, studies on the relationship between reading and depression are not unanimous in their findings. Interestingly, a recent study of grades 4-5 children in Quebec found that increased depressive symptoms were related to increased reading achievement scores over time. The authors suggested that these findings may represent a “pressured student phenomenon”. High scores on a questionnaire assessing depressive symptoms may be identifying individuals who experience high levels of performance anxiety and stress. These children may be achieving higher scores on the reading achievement test because they are more driven to succeed academically.⁸⁴ Another study investigating free-time activities found that time spent reading at age 10 predicted both higher school grades at age 12 as well as higher levels of depression and anxiety at both ages 10 and 12.⁸⁵

Other studies have not found a relationship between reading and depression. A study conducted in Italy found that first grade and third grade school children who had higher levels of depressive symptoms made more spelling errors when dictating words than control children. However, there were no significant differences between children who had high levels of depressive symptoms and control children for reading tasks.⁸⁶ Similarly, another recent study found that

children with dyslexia were not more likely to have higher levels of depressive and anxious symptoms than children with normal reading ability.⁸⁷

Results on the relationship between reading and depression are varied. It is likely a complex relationship involving multiple factors. Some factors that have been shown to be related to early cognitive development and depression are gender,^{88, 89} socioeconomic status,^{90, 91} race,^{13, 88} family type,^{92, 93} gestational age,^{92, 94} parent education^{95, 96} and parent depression.^{97, 98} These factors will be discussed further in the methods sections of the following two chapters.

1.2 SIGNIFICANCE OF EARLY COGNITIVE DEVELOPMENT

A substantial amount of theory and research in the area of cognition and depression was influenced by Beck's cognitive theory of depression. Despite the large amount of literature in the area, Ingram²⁸ points out that much of cognitive theory focuses on proximal causes of depression in adulthood. However, many theories assume that adverse events in early life create a cognitive vulnerability to depression.²⁸ This theory has led to research on differences in cognitive development which may result in differing mental health outcomes. Of particular interest has been the relationship between cognitive development and depression. A recent review stressed the importance of studying depression across the life-course and understanding that there are many contributing factors to depression, including early life factors.²⁷ Studying early life cognitive factors which may make one vulnerable to depression, and their relation to stressful life events both

in childhood and adolescence may provide an important contribution to research on depression.

1.3 OBJECTIVES

For this research we have two overall objectives:

- 1) To investigate whether impaired early cognitive development is related to adolescent depressive symptoms.
- 2) To investigate whether those who have impaired early cognitive development are more likely to suffer from depressive and anxious symptoms after stressful life events in adolescence are considered using interaction models.

1.4 SUMMARY OF RESEARCH PROJECTS

To address these objectives, two studies were conducted using data from a prospective longitudinal cohort study conducted by Statistics Canada, the National Longitudinal Survey of Children and Youth. As described in the second chapter, we investigated the relationship between delayed early developmental milestones and adolescent depressive and anxious symptoms. As indicated in the third chapter, we investigated the relationship between early receptive vocabulary development and adolescent depressive and anxious symptoms.

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CHAPTER 2.0 EARLY DEVELOPMENTAL MILESTONES AND ADOLESCENT DEPRESSION

2.1 BACKGROUND

Relationship to early cognitive development

When studying the cognitive development of very young children, standardized intelligence testing is not available.¹ Early learning in the domains of problem solving and language can be used to assess cognitive development in these very young children.¹ Achievement of early developmental milestones assesses the progression of learning about problem solving and language in young children.

It has long been established that attainment of developmental milestones is delayed among children with learning disabilities.² However, studies have demonstrated that, within the normal range of development, children who achieve motor developmental milestones earlier have higher levels of intelligence in early childhood³ and better executive function in adulthood.⁴ Children who learned to stand without support at an earlier age performed categorization tasks better in adulthood.⁴ Additionally, the attainment of early developmental milestones related to speech development is related positively to later cognitive ability.⁵

Specifically, earlier motor development and earlier speech development were associated with higher levels of intelligence at age 8, higher reading comprehension scores at age 26 and superior performance on verbal fluency tests at age 53.⁵ Earlier attainment of developmental milestones is associated also with higher levels of educational attainment in adulthood.^{5,6} Time of achieving early

developmental milestones has also been shown to be associated with adult brain structure.⁷ Specifically, earlier motor milestone attainment is associated with increased density of white matter in the frontal and parietal lobes, as well as increased density of grey matter in the premotor cortex, striatum and cerebellum.⁷ The authors concluded that these neural systems correlated with adult executive function are structurally related to systems associated with motor development in infants.⁷ In summary, early cognitive development is the basis of intelligence¹ and timing of the attainment of early developmental milestones is an established measure of early cognitive development in young children.

Early Developmental Milestones and Depression

A small body of literature has examined the association between delay in attaining early developmental milestones and future depressive symptoms. A longitudinal study using the 1946 British birth cohort found that later attainment of early motor developmental milestones has been found to be associated with subsequent childhood affective disturbance.⁸ Attaining nocturnal bladder control after the age of four was significantly related to emotional problems for Chinese adolescents⁹ and increased risk of adolescent suicidal behavior.¹⁰ A longitudinal study investigating the trajectory of depressive and anxious symptoms across the life course found that delays in first standing and first walking were significantly associated with depressive and anxious symptoms.¹¹ Hence, delays in attaining some early developmental milestones may predict future depressive symptoms.

Reaction to psychosocial stress is one suggested mechanism by which lower childhood IQ is associated with depression.¹² Individuals with lower childhood IQs may not cope as well with stress, resulting in increased vulnerability to depression after stressful events.¹² To the best of our knowledge, this hypothesis has not been studied in relation to delayed developmental milestones.

The objective of this research was to investigate whether Canadian adolescents who exhibited delay in attaining developmental milestones were more likely than those without delayed milestones to suffer from depressive and anxious symptoms in adolescence. A second objective was to investigate whether those adolescents who exhibited delayed milestones were more vulnerable to depressive and anxious symptoms in adolescence after experiencing stressful life events. Specifically, this objective was to investigate a potential interaction between delayed developmental milestones and stressful life events. We hypothesized that (1) delay in attaining developmental milestones would be associated with depression in adolescence, and (2) Exposure to stressful life events would exacerbate the effects of delayed milestones on depressive and anxious symptoms.

2.2 RESEARCH DESIGN AND METHODS

Source of data

The study used data from the National Longitudinal Survey of Children and Youth (NLSCY), a longitudinal survey conducted by Statistics Canada since 1994/1995.¹³ The survey began with a sample of 16,903 Canadian children

followed prospectively by Statistics Canada every two years. There were data available up to cycle 7 (2006/07) of the survey.

Samples

Sample 1 consisted of children (unweighted $N = 1623$) who were 2-3 years old in cycle 1 (1994/1995) of the NLSCY and responded to self-report measures of depressive and anxious symptoms in cycle 6 of the survey, i.e., when they were ages 12-13. In an attempt to replicate the results in a second independent sample, the same analysis was also conducted on a new sample of children (unweighted $N = 2054$) who were 2-3 years old in cycle 2 (1996/1997) of the NLSCY and responded to self-report measures of anxiety and depression in cycle 7 of the survey, i.e., when they were ages 12-13.

Developmental Milestones

The Motor and Social Development Scale (MSD scale) assesses motor, social and cognitive development of young children (ages 0-47 months).¹⁴ It was developed from scales that are commonly used to assess child development (the Bayley, Gesell and Denver scales) and has high reliability and validity.¹⁴ The Cronbach's alpha was 0.80 for sample 1 and 0.77 for sample 2. The total score for each child on the 15 items on the Motor and Social Development Scale (comprised of both motor and non-motor milestones) was the total number of 'yes' (whether or not the child had achieved the milestone) answers for the 15 questions. This score was age standardized by age in months.¹⁵ Statistics Canada has defined poor developmental attainment as one standard deviation below the mean of the MSD scale¹⁶ and this cut-off has been used in previous studies.¹⁷ Delay was

operationalized by classifying respondents with MSD age standardized scale scores that were one standard deviation below the mean or less as 'delayed'; all other respondents were classified as 'not delayed'. Items from the MSD scale are listed in the appendix.

Emotional Disorder-Anxiety Scale

Youths aged 12 or 13 years self-reported common symptoms of anxiety and depression.¹⁸ The seven items included "I am unhappy or sad", "I am not as happy as other people my age", "I am too fearful or nervous", "I worry a lot", "I cry a lot", "I am nervous, highstrung or tense", and "I have trouble enjoying myself", with three response options: "never or not true", "sometimes or somewhat true", or "often or very true".

The scores for each of the seven items were totaled to give the overall score for the emotional disorder-anxiety scale. These items were derived from the Child Behavior Checklist by investigators for the Ontario Child Health Study on the basis that they appeared to operationalize DSM-III criteria for emotional disorder.¹⁸ The Child Behavior Checklist is a widely used scale that assesses common symptoms of behavioral and emotional problems.¹⁹ The Cronbach's alpha found for the scale for sample 1 was 0.78 and for sample 2 was 0.78. Subjects were then divided into four groups of scores by level of symptoms of depression and anxiety experienced (the score categories were divided to be approximately: 0-50%, no symptoms; 51-75%, mild symptoms; 76-90%,

moderate symptoms; and 91-100%, severe symptoms), in order to capture variation in severity of symptoms. This grouping of depressive symptoms is the same procedure that has been previously used by other researchers.¹¹ This is a convenient way to group the data due to observed floor effects in the data (approximately 50% of individuals scoring 0 or no symptoms on the scale).

Stressful Life Events

In the longitudinal NLSCY cohort, the person most knowledgeable (PMK) for children 4 to 15 years of age was asked “In the past 2 years, has this child experienced any events or situations that caused him / her a great amount of worry or unhappiness?” If the answer to this question was yes, then the PMK was asked to indicate the cause. Categories included: 1) Death of Parents 2) Death in Family 3) Divorce/Separation of Parents 4) Move 5) Death of Pet 6) Stay in Hospital 7) Stay in Foster Home 8) Other Separation from parents 9) Illness/Injury of Child 10) Illness/Injury of family member 11) Abuse/Fear of Abuse 12) Change in Household Members 13) Alcoholism or Mental Health Disorder in Family 14) Other Traumatic Events. If children had experienced one or more of these events since the time of the last interview cycle, they were classified as having a recent stressful life event. Due to sample size restrictions, we could only examine the presence or absence of recent stressful life events. We also examined the effects of stressful life events prior to the past two years. Adolescents were grouped into categories of no previous stressful life events, one previous stressful life event and two or more previous stressful life events,

Covariates

Several potential confounders were included in multivariate analyses. Infant girls score significantly higher than infant boys on the MSD scale.¹⁴ Also, females have significantly higher rates of depression than males; this gender gap is established by adolescence.²⁰ Consequently, gender was controlled for in all multivariate analyses.

Another potential confounder is race.^{14, 21} Caucasian children score higher on the MSD scale than minority children. However, this difference is mainly for older children and there is very little difference in scores for infants.¹⁴ Additionally, it has been suggested that culture may shape how an individual experiences and expresses symptoms of depression.²¹ Subjects were thus grouped into two categories of race: “Caucasian” and “Non-Caucasian”.

Family type is related to children’s MSD scores. Children who are from families including step parents, or father only families had lower scores, while those from two-parent and mother-only families had average scores and those from adopted families had higher than average scores on the MSD scale.²² Parental divorce is associated with increased symptoms of distress in adolescence.²³ Family type was operationalized as a three category variable: single parent families, step parent families and families including both biological parents.

Socioeconomic status has previously been considered a potential confounder in

studies investigating developmental milestones.⁹ Also, depressive symptoms are more common among lower socioeconomic status individuals.²⁴ Socioeconomic status was operationalized as the ratio of household income, controlling to the ‘low-income cut off’ (LICO) score. This measure considers an individual’s income relative to the community in which they live as well as the size of their family.²⁵ The NLSCY divided the measure into six levels, however due to sample size restrictions for the current study the measure was collapsed into three levels. Gestational age was considered as a confounder in the multivariate analysis. Babies who are born preterm have slower development.²² Within the range of full term gestation, a lower gestational age is associated with depressive symptoms (independent of birth weight).²⁶ Gestational age in days was used as a continuous variable in the multivariate analysis.

Supplementary Analysis

In a supplementary analysis, developmental milestones were separated into four groups: self-care milestones, communication milestones, gross motor milestones and fine motor milestones. Self-care milestones, communication milestones and gross motor milestones were continuous variables. However, the NLSCY contained only one question on fine motor milestones in 2-3 year old children, so this was operationalized as a dichotomous variable. Scores were reversed so that a higher score represented fewer milestones having been attained. As these groups were not an age-standardized scale, child age in months was considered as an additional covariate.

Statistical Analysis

Ordinal logistic regression was used to explore the relationship between developmental delay and depressive and anxious symptoms at ages 12-13. Three models were tested, including a fully adjusted analysis (controlling for all potential covariates), a partially adjusted analysis (controlling for gender and socioeconomic status) and a crude analysis. Previous authors have suggested that there may be sex specific associations in the relationship between early cognitive ability and adolescent depression. Given this finding we also conducted sex-stratified analyses for all models.²⁷ The proportional odds assumption that the relationship between each pair of outcome groups is the same, was tested for all models and not violated. Bootstrap weights provided by Statistics Canada were included in the analysis to accommodate for the survey design and to ensure that the sample was representative of the Canadian population. Stata 10 was used to conduct the analysis.

Ethics

The study was approved by the Health Research Ethics Board of the University of Alberta.

2.3 RESULTS

Descriptive statistics are presented in table 2.1. Design-based F-tests were conducted and showed that females were more likely than males to report symptoms of depression and anxiety at age 12-13. Among those aged 2-3 in

1994/95, those with an intact family or from a middle or high-income family were less like to have increased symptoms of depression and anxiety.

Children aged 2-3 in 1994/1995 with delay in reaching developmental milestones had increased odds of anxious and depressive symptoms at ages 12-13 in both the fully adjusted and partially adjusted models (Table 2.2). In the stratified analysis for females, delay was not a significant predictor in any model. In the stratified analysis for males, delay was a significant predictor in the crude and partially adjusted models (Table 2.2). In the sample of 2-3 year olds from 1996/1997, delay was not found to be a significant predictor of anxious and depressive symptoms at ages 12-13.

No significant interaction effects were found between delayed milestone attainment and both recent or previous stressful life events on the likelihood of anxious and depressive symptoms.

Supplementary Analysis

For children aged 2-3 years in 1994/95, decreased attainment of both communication milestones and gross motor milestones was associated with an increased odds of depressive and anxious symptoms in the fully adjusted models. A similar association was seen for self-care milestones ($p=0.055$). For children aged 2-3 years in 1996/97, decreased attainment of both self-care and communication milestones was associated with increased odds of depressive and

anxious symptoms in both the fully adjusted and partially adjusted models (Table 2.3).

In the stratified analysis of children aged 2-3 in 1994/1995, decreased attainment of communication milestones was significantly related to a increased odds of depressive symptoms in males (Table 2.3). A similar association was seen for self-care milestones ($p=0.08$). For females aged 2-3 in 1994/1995, decreased attainment of gross motor milestones was significantly related with an increased odds of depressive symptoms in both the fully adjusted and partially adjusted models (Table 2.3). In the stratified analysis of children aged 2-3 in 1996/1997, decreased self-care milestones were associated with an increased odds of depressive and anxious symptoms in males but not in females (Table 2.3).

Decreased communication milestones were associated with an increased odds of depressive and anxious symptoms in females but not in males in both the partially and fully adjusted models (Table 2.3).

Fine motor milestones were not associated with depressive and anxious symptoms in either the overall analysis or the stratified analysis for either the 1994/1995 sample or the 1996/1997 sample of 2-3 year olds.

2.4 DISCUSSION AND CONCLUSIONS

In this study of 3677 Canadian adolescents followed from birth, there was a significant association between delay in attaining early developmental milestones

and increased depressive and anxious symptoms at ages 12-13. This is consistent with a study which found that delay in first standing and walking were associated with depressive symptoms across the life course.¹¹ Previous studies have linked lower cognitive ability among school-aged children to increased²⁷ and more persistent¹² depressive symptoms, suggesting that cognitive deficits precede the onset of depression. The results of the current study suggest that these cognitive deficits may be present at 2-3 years of age.

The significant finding that delay in attaining early developmental milestones is associated with depressive and anxious symptoms in adolescence was not replicated in sample 2. There was an additional inconsistency that the effect was shown for males but not females in sample 1, but not in sample 2. This contrasts with related findings that have demonstrated that early cognitive ability is associated with adult depressive symptoms in females but not males.²⁷ These inconsistencies likely result from the examination of a relatively small effect which may fail to be detected in some analyses.

No significant interactions were found between either recent or previous stressful life events and delay in attaining developmental milestones. These results do not support a stress-diathesis model for early delays and depression. For recent stressful life events, we used parent report measures of stressful life events over the past two years or since the time of the last interview. This has two important limitations. First, in adolescence the median duration of a depressive episode is

nine months.²⁸ This means that by the time of the assessment of depressive symptoms, the potential increase in depressive symptoms after a stressful life event may have already passed. Second, parents may not be aware about potential school and peer-related stressful life events in a child's life. Hence, there may have been some misclassification in determining whether children had experienced a stressful life event.

In the supplementary analyses, decreased attainment of self-care, gross motor, and communication milestones was significantly associated with increased odds of experiencing depressive and anxious symptoms in adolescence. These results suggest that the relationship between delay in attaining developmental milestones and depressive and anxious symptoms in adolescence is not specific to one domain of developmental milestones.

The results of this study suggested that decreased attainment of motor milestones was related to depressive and anxious symptoms in adolescence. These results are similar to findings in previous research. One longitudinal study found that delays in first standing and first walking were significantly associated with depressive and anxious symptoms.¹¹ This study asked mothers of two year olds to recall the age in months when the child first stood and walked without assistance. The current study suggests that motor milestones (e.g. climbing stairs) are also important for this relationship at later stages of development (ages 2-3).

Decreased attainment of communication milestones was associated with an increased odds of depressive and anxious symptoms in adolescence. This is consistent with findings that children with expressive language delay are more likely to experience social-emotional problems.²⁹ Similarly, there is comorbidity between child communication disorders and child psychiatric disorder.³⁰ Additionally, speech problems in adolescence have been linked to psychiatric disorder in adulthood.³¹ Our findings appear to be consistent with prior studies in this area of research.

Additionally, when males and females were stratified, there was a significant association between decreased attainment of self-care milestones and depressive and anxious symptoms in males, but not females. A study of parenting conducted across 110 societies demonstrated that after infancy parents exerted pressure on girls to be nurturing and responsible whereas more pressure was put on boys to be self-reliant and to strive for achievement.³² It may be that achievement of independence from caregivers is both culturally and, in turn, psychologically more important for boys. This could underlie this gender difference in the relationship between these early milestones and adolescent mental health. This could represent an environmental modulator of cognitive vulnerability to depression.

There are four main limitations to the study. First, the measures used in this study do not include a clinical diagnosis of depression, but rather, rely on self-report of

symptoms of depression. However, recent findings suggest that subthreshold depressive disorders occur commonly in the population and produce significantly decreased health.³³ By using the self-report measure of depressive symptoms, this study may have the advantage of capturing some of these subthreshold depressive disorders. The second limitation of this study is that early developmental assessments are limited to a parent reported questionnaire on developmental milestone attainment rather than validated developmental screening tools or developmental assessments by health care professionals. However, early developmental milestones are indicative of current cognitive development¹ and are related to subsequent childhood and adult cognitive function.⁵ The third limitation of this study worth mentioning is that outcomes were measured in 12-13 year olds. A recent study suggests that the relationship between cognitive ability in childhood and depressive symptoms in adolescence is dependent on age and/or pubertal stage.³⁴ Specifically, the study found that child IQ at age 8 was inversely associated with depressive symptoms at age 11. However, at age 13-14 the association reversed and a higher IQ score at age 8 was associated with higher risk of symptoms of depression.³⁴ The current study examined depressive symptoms in 12-13 year olds and thus these results may be affected by subjects with differing ages and pubertal stages. In the stratified analysis of males and females from 1994/1995, developmental delay was a significant predictor of depression in the crude and partially adjusted models for males, but not females. This may be due to the fact that males undergo puberty later than females. The fourth limitation of the study is that we dichotomized the originally continuous

MSD score. Categorizing continuous variables can result in a loss of power and precision. However we were interested in answering a question about those with impaired early development. Dichotomizing one standard deviation below the mean of the MSD scale is the recommended cut-point by Statistics Canada to assess poor developmental attainment.¹⁶ As the objective of this study was to answer a question about those with delayed development it may justify dichotomizing this variable. However, the potential for loss of power and precision is acknowledged.

These limitations are offset by notable strengths, including the prospective design and a large sample size representative of the Canadian population. The results imply that early cognitive development is related to adolescent mental health. These findings suggest that cognitive deficits precede the onset of depression and are not solely a state characteristic of depression, but are also likely to be a pre-morbid trait of some individuals who develop depression.

Table 2.1 Descriptive statistics for cycle 1 and cycle 2 samples

Variable	CYCLE 1 SAMPLE		CYCLE 2 SAMPLE	
	Weighted Mean (SE)/ Weighted Percentage	95% CI	Weighted Mean (SE)/ Weighted Percentage	95% CI
Gender	50.60% (Male)		51.36% (Male)	
Age	49.28% (2 Year Olds)		48.10% (2 Year Olds)	
Income (Continuous)	1878.87 (45.55)	1789.53 , 1968.21	1832.82 (38.98)	1756.37 , 1909.27
Income (Categorical)	6.36% (Mid) 74.29% (High)		9.07% (Mid) 72.92% (High)	
Gestational Age (Days)	272.98 (0.70)	271.60 , 274.36	273.11 (0.42)	272.29 , 273.93
Race	89.00% (Caucasian)		82.28% (Caucasian)	
Family Type	5.62% (Step Parent Families) 12.58% (Single Parent Families)		7.18% (Step Parent Families) 11.39% (Single Parent Families)	
Emotional Disorder/Anxiety Score (Continuous)	3.36 (0.10)	3.15 , 3.57	3.39 (0.10)	3.20 , 3.57
Emotional Disorder/Anxiety Score (Categorical)	24.37% (Low- Mid) 24.33% (Mid) 7.16% (High)		24.83% (Low- Mid) 23.63% (Mid) 7.07% (High)	
Motor and Social Development Scale Score (Unstandardized and continuous)	9.60 (0.17) (2 year olds) 12.80 (0.11) (3 year olds)	9.26 , 9.93 12.58 , 13.03	9.92 (0.13) (2 year olds) 13.16 (0.09) (3 year olds)	9.66 , 10.18 12.99 , 13.33

	11.22 (0.11) (overall)	11.0 , 11.45	11.60 (0.09) (overall)	11.42 , 11.79
Motor and Social Development Scale Score (Age standardized and dichotomous)	15.73% (Delay)		14.32% (Delay)	
Selfcare Milestones Score ^a	1.12 (0.07) (2 year olds)	0.98 , 1.27	1.13 (0.05) (2 year olds)	1.02 , 1.23
	0.43 (0.04) (3 year olds)	0.36 , 0.51	0.32 (0.02) (3 year olds)	0.27 , 0.37
	0.77 (0.04) (overall)	0.69 , 0.86	0.71 (0.03) (overall)	0.65 , 0.77
Communication Milestones Score ^a	1.72 (0.09) (2 year olds)	1.55 , 1.89	1.64 (0.06) (2 year olds)	1.51 , 1.76
	0.61 (0.05) (3 year olds)	0.51 , 0.72	0.53 (0.04) (3 year olds)	0.45 , 0.62
	1.16 (0.05) (overall)	1.05 , 1.26	1.06 (0.04) (overall)	0.98 , 1.15
Gross Motor Milestones Score ^a	1.38 (0.07) (2 year olds)	1.25 , 1.52	1.18 (0.05) (2 year olds)	1.09 , 1.27
	0.56 (0.05) (3 year olds)	0.45 , 0.66	0.41 (0.04) (3 year olds)	0.33 , 0.50
	0.96 (0.04) (overall)	0.88 , 1.05	0.78 (0.03) (overall)	0.72 , 0.84
Fine Motor Milestones Score ^a (Dichotomous)	90.71% (2 year olds)		87.59% (2 year olds)	
	54.50% (3 year olds)		52.88% (3 year olds)	
	72.35% (overall)		69.57% (overall)	
Recent Stressful Life Events (Continuous)	0.36 (0.02)	0.32 , 0.41	0.40 (0.02)	0.36 , 0.44
Recent Stressful Life Events (categorical)	31.67% (One or more)		34.58% (One or more)	

Previous Stressful Life Events (Continuous)	0.99 (0.04)	0.91 , 1.07	0.99 (0.03)	0.92 , 1.05
Previous Stressful Life Events (categorical)	33.61% (One)		36.09% (One)	
	27.20% (Two or more)		25.92% (Two or more)	

a: Scale inversed, represents number of milestones unachieved

Table 2.2 Association between delayed milestone attainment at age 2-3 and symptoms of depression and anxiety in adolescence

Delayed Milestones		
	<i>Cycle 1 Sample</i>	<i>Cycle 2 Sample</i>
All		
Crude	1.44 (0.97-2.14)	0.96 (0.68-1.36)
Adjusted ¹	*1.54 (1.04-2.27)	1.23 (0.85 -1.76)
Adjusted ²	*1.53 (1.02-2.28)	1.24 (0.84-1.83)
Males		
Crude	*1.67 (1.04-2.66)	1.15 (0.72-1.84)
Adjusted ³	*1.69 (1.03-2.79)	1.22(0.76-1.97)
Adjusted ⁴	1.59 (0.96-2.65)	1.15(0.68-1.93)
Females		
Crude	1.61 (0.80-3.23)	1.16 (0.68-2.01)
Adjusted ³	1.42 (0.71-2.86)	1.28 (0.74-2.22)
Adjusted ⁴	1.43 (0.65-3.16)	1.63 (0.92-2.89)

¹ Adjusted for gender and SES

² Adjusted for gender, race, SES, family type and gestational age

³ Adjusted for SES

⁴ Adjusted for race, SES, family type and gestational age

*p<0.05

Table 2.3 Association between categories of developmental milestones and depressive symptoms in adolescence

	Self Care	Communication	Motor	Fine Motor
<i>Sample 1</i>				
All				
Crude	1.06 (0.91-1.23)	**1.17 (1.06-1.29)	1.10 (0.96-1.26)	0.87 (0.66-1.15)
Adjusted ¹	1.14 (0.98-1.32)	***1.30 (1.14-1.47)	1.12 (0.97-1.30)	0.97 (0.70-1.32)
Adjusted ²	1.16 (1.00-1.35)	***1.31 (1.15-1.49)	*1.18 (1.01-1.37)	0.97 (0.70-1.34)
Males				
Crude	1.18 (0.99-1.41)	***1.34 (1.18-1.52)	1.06 (0.88-1.27)	1.35 (0.86-2.13)
Adjusted ³	1.19 (0.96-1.46)	***1.41 (1.21-1.64)	1.04 (0.85-1.28)	1.28 (0.77-2.11)
Adjusted ⁴	1.21 (0.98-1.50)	***1.35 (1.16-1.57)	1.10 (0.90-1.35)	1.30 (0.78-2.20)
Females				
Crude	1.06 (0.81-1.40)	1.08 (0.90-1.30)	1.15 (0.96-1.39)	0.78 (0.54-1.12)
Adjusted ³	1.08 (0.82-1.42)	1.13 (0.91-1.40)	*1.23 (1.01-1.51)	0.77 (0.52-1.16)
Adjusted ⁴	1.07 (0.80-1.42)	1.20 (0.95-1.50)	*1.27 (1.02-1.58)	0.76 (0.50-1.15)
<i>Sample 2</i>				
All				
Crude	1.04 (0.92-1.17)	1.06 (0.96-1.17)	0.94 (0.82-1.07)	0.93 (0.73-1.18)
Adjusted ¹	*1.15 (1.00-1.33)	*1.13 (1.01-1.26)	0.96 (0.81-1.12)	0.98 (0.74-1.30)
Adjusted ²	*1.17 (1.01-1.36)	*1.14 (1.02-1.28)	0.96 (0.82-1.14)	0.96 (0.72-1.29)
Males				
Crude	**1.23 (1.05-1.43)	1.10 (0.96-1.26)	1.06 (0.88-1.27)	0.95 (0.64-1.40)
Adjusted ³	*1.26 (1.04-1.52)	1.06 (0.91-1.24)	1.01 (0.80-1.27)	0.86 (0.55-1.34)

Adjusted ⁴	*1.26 (1.04-1.54)	1.08 (0.92-1.26)	0.99 (0.78-1.26)	0.82 (0.52-1.30)
Females				
Crude	0.96 (0.77-1.19)	1.07 (0.89-1.27)	0.86 (0.70-1.06)	1.06 (0.78-1.46)
Adjusted ³	1.03 (0.84-1.28)	*1.22 (1.03-1.44)	0.89 (0.72-1.11)	1.12 (0.80-1.59)
Adjusted ⁴	1.07 (0.85-1.36)	*1.26 (1.04-1.52)	0.93 (0.74-1.17)	1.13 (0.79-1.61)

¹ Adjusted for gender, age in months and SES

² Adjusted for gender, age in months, race, SES, family type and gestational age

*p<0.05

**p<0.01

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CHAPTER 3.0 EARLY LANGUAGE DEVELOPMENT AND ADOLESCENT DEPRESSION

3.1 BACKGROUND

Early language development is important for children's school readiness

School readiness is a multidimensional construct consisting of cognitive, emotional, behavioral and knowledge-related factors that prepare the child to learn when they enter formal schooling.¹ The cognitive development that underlies a child's readiness to learn in school is essential for their future academic success.

Vocabulary development is a critical factor in children's school readiness.

Children first need to learn the meaning of words in order to understand the material they are reading.² Early child vocabulary has been shown to mediate the relationship between home factors and school readiness.³ Specifically, home factors such as exposure to reading contribute to the child's language skills, which in turn contribute to the child's school readiness.³ Another study showed children who had language difficulties at 54 months showed decreased school readiness.⁴ The authors of this study looked at the relationship between school readiness and early language difficulties. They concluded that language difficulties that persist through early childhood do not necessarily pose a risk to school readiness as long as they are resolved by the time of school entry.⁴ Overall, early language ability is an essential component of school readiness and has important implications for future academic success.

Receptive Vocabulary Development

Receptive vocabulary is a widely studied area of early language development. Receptive vocabulary knowledge refers to the ability of an individual to understand the meaning of words. Tests of receptive vocabulary knowledge are generally considered to be tests of cognitive ability.^{5,6} Receptive vocabulary tests correlate significantly with measures of intelligence^{7,8} and academic achievement.⁹ Some tests of receptive vocabulary have been identified as having decision making components that have implicit demands for executive functioning skills.¹⁰ Additionally, scores on receptive vocabulary tests have been linked to brain structure. Specifically, left and right temporal volumes are significant predictors of receptive vocabulary knowledge in typically developing children.¹⁰

Early life exposure to books in the home plays a key role in the development of reading skills important for future academic success.¹¹ Listening to an adult read storybooks contributes to young children's vocabulary growth^{11,12} and listening comprehension skills.¹¹ These skills are directly related to children's reading ability in third grade.¹¹ It has been postulated that reading storybooks to children is important for early cognitive development because it allows the child to listen to repeated verbal behaviours by parents, provoking imitation by the child.¹³ Reading to young children helps to expand their vocabulary and is important for early cognitive development.

Children who are poor readers have less advanced receptive vocabulary knowledge than children who are good readers.¹⁴ The absence of regular reading to young children is associated with impaired receptive vocabulary development at age 5.¹⁵ Interventions that expose children to storybooks improve receptive vocabulary scores in young children (ages 18-25 months¹⁶ and 2-5 years¹⁷). A longitudinal study found that exposure to storybooks in the home was important for receptive language development.¹¹

Reading and Developmental Delay

It has been postulated that surface reading difficulties (a selective deficit in developing the lexical procedure identified through poor reading of exception words (e.g. yacht)¹⁸) could be partly attributable to general developmental delay.¹⁹ Specifically, very low birth weight children are more likely to suffer from general developmental delay and these children display surface reading difficulties.¹⁹ Early reading difficulties have been linked to impairments in both motor²⁰ and language development²¹ in children. It has been postulated that early reading to young children may be especially important for cognitive development among children with developmental delay.²²

Receptive Vocabulary and Mental Health

It is well established that early childhood language impairments are associated with mental health problems in adolescence^{23, 24} and early adulthood.^{25, 26}

However, studies that look specifically at measures of receptive vocabulary are less conclusive.

Cross-sectional studies have investigated the relationship between depressive symptoms and receptive vocabulary. Higher receptive vocabulary in preschool children are associated with fewer internalizing symptoms.²⁷ However this relationship has not been consistently identified. Lower receptive vocabulary knowledge was not associated with high depressive symptoms in a study of 9-11 year olds.²⁸

Some research has been done investigating the potential relationship between early impairment in receptive vocabulary knowledge and adult mental health. A prospective longitudinal study found that adults who had been diagnosed with schizophrenia had lower childhood receptive vocabulary knowledge.⁵ Similarly, children with a family history of schizophrenia score lower on tests of receptive vocabulary knowledge.²⁹

Some longitudinal studies have investigated the relationship between early receptive vocabulary and later mental health in both children and adults.

Receptive language difficulties at ages 15, 24, 36 and 54 months do not predict kindergarten internalizing behavior.⁴ One longitudinal study found that receptive vocabulary knowledge at age 3 was not significantly correlated with self-reported depressive symptoms at age 7.³⁰ Similarly, receptive knowledge in kindergarten

was not associated with third grade internalizing problems.³¹ Similarly, a longitudinal cohort study did not find significant differences in early receptive vocabulary scores between 26 year olds with anxiety/depression and those without.³² However, a recent longitudinal cohort study found early receptive language problems to be a significant risk factor for mental health problems and well-being at age 34.¹⁵ Many of the studies that have been conducted in this area have looked at a short time frame with outcomes in childhood. Findings from longitudinal cohort studies with adult outcomes differ perhaps due to using different outcome measures, self-report¹⁵ versus clinical diagnosis.³² However to the best of our knowledge no previous authors have investigated this relationship across adolescence. Additionally, it would be informative to use a spectrum of severity of depressive symptoms rather than a dichotomous outcome. Previous research has demonstrated that subthreshold depressive disorders are common and are associated with diminished health outcomes. This may not be captured by a dichotomous outcome of depression.³³ Previous studies which have used a self report measure of depressive symptoms in adulthood have found a relationship between early receptive language development and depressive symptoms so we would expect to find the same in an adolescent population.

The Current Study

The relationship between impaired early receptive vocabulary development and adolescent depressive symptoms has not been established. The objectives of the current study are:

1. To determine whether impaired receptive vocabulary development at ages 4-5 is associated with increased odds of adolescent depressive and anxious symptoms.
2. To determine whether impaired receptive vocabulary development at ages 4-5 is associated with increased odds of adolescent depressive and anxious symptoms after the occurrence of stressful life events.
3. To determine whether reading to children on a regular basis at ages 2-3 is associated with reduced odds of adolescent depressive and anxious symptoms.
4. To determine whether reading regularly to young children who are delayed in attaining developmental milestones is associated with a decrease in odds of depressive and anxious symptoms in adolescence compared to children who are not delayed.

3.2 RESEARCH DESIGN AND METHODS

Source of data

The study used data from the National Longitudinal Survey of Children and Youth (NLSCY), a longitudinal survey which has been conducted by Statistics Canada since 1994/1995.³⁴ The survey began with a sample of 16,903 Canadian children who have been followed prospectively by Statistics Canada every two years. There were data available up to cycle 8 (2008/09) of the survey.

Sample

The sample consisted of children who were 2-3 years old in cycle 1 (1994/1995)

of the NLSCY and responded to self-report measures of depressive and anxious symptoms in adolescence. There are four outcome periods of interest in this study: cycle 5 of the survey (ages 10-11) $n=1514$, cycle 6 of the survey (ages 12-13) $=1690$, cycle 7 of the survey (ages 14-15) $=1573$, and cycle 8 of the survey (ages 16-17) $=1243$. The sample size was smaller for children who responded to questions in cycle 2 at age 4-5 and were followed up in adolescence: cycle 5 $n=1341$, cycle 6 $n=1516$, cycle 7 $n=1419$ and cycle 8 $n=1132$.

Early Receptive Vocabulary Skills

The Peabody Picture Vocabulary Test–Revised (PPVT-R) was developed by Lloyd and Leota Dunn at the University of Hawaii.³⁵ In the NLSCY, it was used to assess receptive vocabulary skills (an important factor for school readiness) in children aged 4-5, as well as children 6 and older who were not yet in grade 2 in cycle 2 of the NLSCY. The interviewer read out words and the children were shown pictures and asked to identify which picture matched the spoken word. A total raw score was calculated given the number of correct responses. These scores were then age standardized by two-month age groups to ensure comparability across age groups. For the current study, the age standardized PPVT-R score from 4-5 year olds was dichotomized into low (1 SD deviation below the mean) and high (above 1 SD below the mean). This grouping has been previously used to differentiate those with poor and normal receptive language skills¹⁵ and is the recommended cut-point by Statistics Canada for assessing poor developmental attainment using the PPVT-R.³⁶ Examples of items from the PPVT-R are shown in the appendix.

Early Reading

The NLSCY contains several questions on several early literacy activities. The parents of 2-3 year olds were asked: "Have you or another adult ever read aloud to child on a regular basis?". The response options for this question were "yes" or "no". This question was used to determine the presence or absence of reading to young children. Early reading in the next cycle (4-5 year olds) could not be examined due to sample size restrictions.

Depressive Symptoms in Adolescence

Youths aged 10-15 self-reported common symptoms of anxiety and depression.³⁷ The seven items included "I am unhappy or sad", "I am not as happy as other people my age", "I am too fearful or nervous", "I worry a lot", "I cry a lot", "I am nervous, highstrung or tense", and "I have trouble enjoying myself", with three response options: "never or not true", "sometimes or somewhat true", or "often or very true". In 2004/2005, Statistics Canada calculated the Cronbach's Alpha for the emotional disorder anxiety scale to be 0.73 for 10-11 year olds, 0.78 for 12 to 13 year olds, and 0.78 for 14 to 15 year olds.³⁸

The scores for each of the seven items were totaled to give the overall score for the emotional disorder-anxiety scale. Subjects were then divided into four groups of scores by level of symptoms of depression and anxiety experienced (the score categories were divided to be approximately: 0-50%, no symptoms; 51-75%, mild symptoms; 76-90%, moderate symptoms; and 91-100%, severe symptoms), in order to capture variation in severity of symptoms. This grouping of depressive

symptoms is the same grouping that has been previously used by other researchers.³⁹ It is a convenient way to group data due to observed floor effects in the data (approximately 50% of subjects score 0 on the scale, or no symptoms).

Youths 16-17 answered a self-reported depression questionnaire. The questionnaire is based on a shorter version of the CES-D comprising 20 questions developed by L.S. Radloff of the Epidemiology Study Center of the National Institute of Mental Health in the U.S.⁴⁰ Dr. M. Boyle at McMaster University in Ontario reduced the scale to 12 questions on the occurrence and severity of symptoms of depression during the past week. This 12 question version is used in the NLSCY.⁴⁰ The items from the depression questionnaire are listed in the appendix. The standardized Cronbach's Alpha for the depression score for 16-17 year olds on cycle 8 of the NLSCY was 0.83.⁴⁰

The scores for each of the twelve items were totaled to give the overall score for the depression scale. As with the outcomes from 10-15 year olds, subjects were then divided into four groups of scores by level of symptoms of depression and anxiety experienced (the score categories were divided to be approximately: 0-50%, no symptoms; 51-75%, mild symptoms; 76-90%, moderate symptoms; and 91-100%, severe symptoms), in order to capture variation in severity of symptoms. This grouping of depressive symptoms is the same grouping that has been previously used by other researchers.³⁹ It is a convenient way to group data due to observed floor effects in the data (approximately 50% of subjects score 0

on the scale, or no symptoms).

Stressful Life Events

In the longitudinal NLSCY cohort, the person most knowledgeable (PMK) for children 4 to 15 years of age was asked “In the past 2 years, has this child experienced any events or situations that caused him / her a great amount of worry or unhappiness?” If the answer to this question was yes, then the PMK was asked to indicate the cause. Categories included: 1) Death of Parents 2) Death in Family 3) Divorce/Separation of Parents 4) Move 5) Death of Pet 6) Stay in Hospital 7) Stay in Foster Home 8) Other Separation from parents 9) Illness/Injury of Child 10) Illness/Injury of family member 11) Abuse/Fear of Abuse 12) Change in Household Members 13) Alcoholism or Mental Health Disorder in Family 14) Other Traumatic Events. If children had experienced one or more of these events since the time of the last interview cycle, they were classified as having a recent stressful life event. Due to sample size restrictions, recent stressful life events could not be broken down into more categories. If they had experienced stressful events prior to this time, they were classified as having either no past stressful life events, one past stressful life event or two or more stressful life events.

To determine recent stressful life events for youths aged 16 to 17 we used self-report items for the NLSCY. Youths aged 16-17 were asked “In the past two years, have you personally been through any of these events?: a painful breakup with a boyfriend or girlfriend, a serious problem in school or at work, a pregnancy

or an abortion, the death of someone close to you;, the divorce or separation of your parents, another difficult event” . If youths had experienced one or more of these events since the time of the last interview cycle, they were classified as having a recent stressful life event. Due to sample size restrictions, recent stressful life events could not be broken down into more categories. If they had experienced one or more of the previously described parent reported events prior to this time, they were classified as having either no past stressful life events, one past stressful life event or two or more stressful life events.

Developmental Milestones

The Motor and Social Development Scale (MSD scale) is intended to assess the motor, social and cognitive development of young children (ages 0-47 months).⁴¹ It was developed from scales that are commonly used to assess child development (the Bayley, Gesell and Denver scales) and has high reliability and validity.⁴¹ The total score for each child on the 15 items on the Motor and Social Development Scale was the total number of ‘yes’ (whether or not the child had achieved the milestone) answers for the 15 questions. This score was age standardized by age in months.³⁸ Delay was considered to be one standard deviation below the mean which is the recommended cut-off by Statistics Canada to assess poor developmental attainment³⁶ and has been used in previous studies.⁴² Items from the MSD scale are listed in the appendix.

Covariates

Several potential confounders were included in multivariate analyses. Females at age 5 have been shown to have poorer receptive language skills than males.¹⁵ Gender differences have also been found in at home oral reading practices.⁴³ Specifically, a pattern relatively enriched language interaction during shared reading has been observed between mothers and their daughters in comparison with mothers and sons.⁴³ Also, females have significantly higher rates of depression than males; this gender gap is established by adolescence.⁴⁴ Gender was controlled for in all multivariate analyses.

Family income is another important covariate to consider. Higher income homes may provide a more stimulating learning environment for young children.⁴⁵ Higher socioeconomic status is associated with increased frequency of maternal reading to children.⁴⁶ Children with poor receptive vocabulary skills are more likely to grow up in disadvantaged family circumstances than those with better receptive vocabulary skills.¹⁵ Also, depressive symptoms are more common among individuals of lower socioeconomic status.⁴⁷ Therefore, socioeconomic status was controlled in all multivariate analyses. Socioeconomic status was operationalized as the ratio of household income, over the 'low-income cut off' (LICO) score. This measure considers an individual's income relative to the community in which they live as well as the size of their family.⁴⁸ The NLSCY divided the measure into six levels. However due to sample size restrictions (meaning the numbers of individuals belonging to some categories of family

income in some categories of depressive symptoms were low), the measure was collapsed into three levels for the current study.

PMK education was considered as a confounder in the multivariate analysis.

Parent education is an important covariate as children of higher educated parents perform better on tests of cognitive and academic ability.⁴⁵ Children with poor receptive vocabulary are more likely to have parents that left school at the minimum age.¹⁵ Maternal education is associated with frequency of reading to children.⁴⁹ Low maternal education is significantly associated with depression in adolescence.⁵⁰ The NLSCY question on highest level of PMK education obtained was used. This is a four category variable which included: less than secondary, secondary school graduation, beyond high school and college or university degree (including trade).

PMK depression was considered as a potential confounder in the multivariate analysis. Children with poor receptive vocabulary are more likely to have a mother who is depressed.¹⁵ Mothers who are depressed exhibit significantly more negative and disengaged behavior with their children than non-depressed mothers,⁵¹ which may affect children's school readiness. Additionally, parental depression is associated with the quality of shared book reading experiences with children.⁵² Parental depression is also a risk factor for development of depression.⁵³ The same 12 item depression scale that was administered to 16-17 year olds (described above) was administered to the PMK. The items from the

depression scale are listed in the appendix. Similarly, the PMK depression scores were divided into four groups of scores by level of symptoms of depression and anxiety experienced (the score categories were divided to be approximately: 0-50%, no symptoms; 51-75%, mild symptoms; 76-90%, moderate symptoms; and 91-100%, severe symptoms), in order to capture variation in severity of symptoms. This grouping of depressive symptoms is the same procedure that has been previously used by other researchers.³⁹

Statistical Analysis

Ordinal logistic regression was used for the analysis. The proportional odds assumption that the relationship between each pair of outcome groups is the same, was tested for all models and in the instances it is violated, multinomial logistic regression was used. Three models were investigated: the fully adjusted model controlling for parent depression, parent education, gender and SES; the partially adjusted model controlling for gender and SES; additionally a crude model was investigated. These models were tested first using receptive vocabulary scores as the exposure, and then whether or not the child had been read to. Bootstrap weights provided by Statistics Canada were included in the analysis to accommodate for the survey design and to ensure that the sample is representative of the Canadian population. Stata 10 was used to conduct the analysis.

3.3 RESULTS

Descriptive statistics are presented in table 3.1. None of the results were

significant for the analysis investigating the relationship between impaired receptive vocabulary and adolescent depressive symptoms (Table 3.2). The crude model for 10-11 year olds was nearly significant ($p=0.07$) indicating that increased depressive symptoms may be present for 10-11 year olds who had had impaired vocabulary development at ages 4-5. However, this relationship did not reach significance and after adjusting for covariates was no longer present. Additionally, there were no significant interactions between impaired receptive vocabulary in 4-5 year olds and stressful life events in terms of subsequent risk of depression.

None of the results were significant for the analysis investigating the relationship between 2-3 year olds ever having been read to on a regular basis and adolescent depressive symptoms (Table 3.3). In the ordinal logistic regression analysis of the partially adjusted model for 14-15 year olds, the proportional odds assumption was violated. The results of the multinomial logistic regression analysis were not significant. For 16-17 year olds in the fully adjusted model, there appeared to be a higher odds of depressive symptoms for children who had been read to on a regular basis, but this did not reach significance ($p<0.10$). Additionally, there were no significant interactions between the child ever having been read to on a regular basis and delay in attaining developmental milestones.

3.4 DISCUSSION AND CONCLUSIONS

The finding that impaired receptive vocabulary development at age 4-5 was not associated with increased symptoms of depression in adolescence is consistent with studies that have not found a relationship between impaired early receptive vocabulary and childhood internalizing behaviors^{4,30,31} as well as adult depression/anxiety.³² However, our findings are contrary to a recent study which found that men and women (at age 34) with poor receptive vocabulary at age 5 were more likely to be depressed.¹⁵ One potential explanation for this inconsistency is that this previous study looked at adults at age 34 whereas our study looked at adolescents. Receptive vocabulary knowledge is considered an important factor in school readiness. Children entering school with higher school readiness are more likely to succeed academically.⁵⁴ Academic success may help adults to find higher paid employment opportunities and it is well established that lower SES is linked to depression.⁴⁷ However, this relationship may not be as important for adolescents who have not yet left their parent's homes. Some authors have hypothesized that there would not be a relationship between receptive vocabulary knowledge and depression²⁸ because depressed adults do not perform more poorly on measures of verbal intelligence than non-depressed adults.^{55,56} Our study findings appear to be consistent with this hypothesis.

No significant interactions were found between either recent or previous stressful life events and impaired receptive vocabulary development. These results do not support a stress-diathesis model for impaired receptive vocabulary development

and depression. For recent stressful life events in 10-15 year olds, we used parent report measures of stressful life events over the past two years or since the time of the last interview. This has two important limitations. First, in adolescence the median duration of a depressive episode is nine months.⁵⁷ This means that by the time of the assessment of depressive symptoms, the potential increase in depressive symptoms after a stressful life event may have already passed (this is also relevant for self-reported stressful life events in 16-17 year olds). Second, parents may not be aware about potential school and peer-related stressful life events in a child's life. Hence, there may have been some misclassification in determining whether children had experienced a stressful life event.

Children who had been read to on a regular basis at ages 2-3 were no less likely to be depressed than children who had not been read to on a regular basis. This is not the result we had expected, given that reading books to preschoolers is related to emergent literacy, language growth and reading achievement⁵⁸ and that deficits in reading ability are associated with depression.⁵⁹⁻⁶³ However, our lack of significant findings may have to do with the nature of our question. The research question dealt with the presence or absence of shared reading experiences, not the quality of shared reading experiences. It is well established that children learn more vocabulary from shared reading experiences if they are actively engaged in the book reading rather than passively listening to the storybook being read to them.⁶⁴ If we had information on whether the child was actively or passively engaged in storybook reading, we may have found a significant effect for children

who were actively involved (asking questions, discussing etc.) in storybook reading. However, as our results showed that early receptive vocabulary was not significantly related to adolescent depression, it may simply be that early reading is also unrelated to adolescent depression.

One surprising effect was that after controlling for all potential covariates there appeared to be a higher odds of depressive symptoms in 16-17 year olds for children who had been read to on a regular basis at ages 2-3, but this did not reach significance ($p < 0.10$). It is possible that this may not be an effect of reading to young children, but may actually reflect a “pressured student phenomenon”.⁶⁵ A recent study of grades 4-5 children in Quebec found that increased depressive symptoms were related to increased reading achievement scores over time.⁶⁵ The authors suggested that these findings may represent a “pressured student phenomenon”. High scores on a questionnaire assessing depressive symptoms may be identifying individuals who experience high levels of performance anxiety and stress. These children may be achieving higher scores on the reading achievement test because they are more driven to succeed academically.⁶⁵ We may be observing something similar in our findings. It is possible that young children who are read to on a regular basis may have parents who put more emphasis on the importance of academic success. At age 16-17, high school students may be feeling more pressure and stress to succeed academically for university and college admissions. Higher scores observed on our measure of

depressive symptoms may be identifying individuals who experience high levels of performance anxiety and stress.

Our study did not find any significant interactions between the child ever having been read to on a regular basis and delay in attaining developmental milestones. This suggests that reading to young children who are delayed is not more important than reading to young children who are not for preventing depressive symptoms in adolescence. Again, as previously discussed, the lack of a measure of shared-reading quality may be an issue when looking at this relationship.

Our study has several important limitations. The first is the lack of a measure of shared-book reading experience quality. Children learn more from shared reading experiences if they are actively engaged in the book reading rather than passively listening to the storybook being read to them.⁶⁴ Additionally, we rely on parent report of the presence or absence of regular shared book reading. Responses to this question may be influenced by social desirability. It has been argued that the reason some studies have found weak correlations between reading to children and vocabulary development⁶⁶ may in fact be due to a measurement problem of parent report.⁶⁷ To avoid this measurement problem, Senechal et al. (1996) made up a checklist of real and made-up book titles to test parents actual knowledge of children's books as a proxy measure of how often parents read to their children (reasoning that parents who read more to their children would have more knowledge of children's books). They expected that this would negate the

measurement problem due to social desirability. They found that parents' scores on the children's book exposure check-list predicted their children's receptive vocabulary knowledge.⁶⁷ We did not have such a measure and had to rely on parent report of shared-book reading activities which, may be subject to the influence of social desirability. Additionally, the study does not have a clinical diagnosis of depression and relies on self-report of symptoms of depression. However, recent findings suggest that subthreshold depressive disorders occur commonly in the population and produce significantly decreased health.³³ By using the self-report measure of depressive symptoms, this study may have the advantage of capturing some of these subthreshold depressive disorders. Another issue that should be mentioned is that we dichotomized the originally continuous PPVT-R score. Categorizing continuous variables can result in a loss of power and precision. However we were interested in answering a question about those with poor receptive language development. Dichotomizing one standard deviation below the mean has been used previously to define poor receptive language development.¹⁵ As the objective of this study was to answer a question about those with poor receptive language development it may justify dichotomizing this variable. However, the potential for loss of power and precision is acknowledged.

These limitations are offset by notable strengths, including the prospective design and a large sample size representative of the Canadian population. The current study failed to find a relationship between early receptive vocabulary and adolescent depressive symptoms. The current study also failed to find a

relationship between early reading experiences and adolescent depressive symptoms.

Table 3.1 Descriptive Statistics based on first outcome period (Cycle 5)

Variable	Weighted Mean (SE) / Weighted Percentages	95% CI
Gender	50.35% (Male)	
Age	45.11% (2 year olds)	
Parent Income (Continuous)	1802.69 (45.85)	1712.76 , 1892.62
Parent Income (Categorized)	6.82% (Mid) 71.18% (High)	
Motor and Social Development Score (Unstandardized and continuous)	10.06 (0.20) (2 year olds) 12.99 (0.10) (3 year olds) 11.66 (0.12) (overall)	9.67 , 10.45 12.79 , 13.19 11.43 , 11.88
Motor and Social Development Score (Age standardized and Dichotomized)	14.48% (Delay)	
Reading exposure	93.49% (Exposed to reading)	
Parent Depression Score (Continuous)	5.24 (0.25)	4.75 , 5.74
Parent Depression Score (Categorized)	28.00% (Low-Mid) 15.09% (Mid) 9.99% (High)	
PMK Education	18.74% (Secondary school graduation) 27.78% (Beyond secondary school) 37.93% (College or university degree, including trade)	

PPVT-R Score (Unstandardized and continuous)	52.49 (1.27) (4 year olds)	58.66 , 62.28
	67.22 (1.13) (5 year olds)	50.00 , 54.98
	60.47 (0.92) (Overall)	65.01 , 69.45
PPVT-R Score (Age standardized and dichotomized)	14.55% (Low score)	
Emotional disorder/anxiety score (Continuous)	3.79 (0.13)	3.53 , 4.06
	Emotional disorder/anxiety score (Categorized)	20.44% (Low-Mid)
	18.15% (Mid)	
	10.19% (High)	
Recent Stressful Life Events (continuous)	34.54 (0.02)	0.30 , 0.39
Recent Stressful Life Events (Categorized)	32.84% (One or more)	
Previous Stressful Life Events (continuous)	0.72 (0.03)	0.66 , 0.79
Previous Stressful Life Events (Categorized)	34.58% (One)	
	16.42% (Two or more)	

Table 3.2 The relationship between impaired receptive vocabulary development at age 4-5 and adolescent depressive symptoms (Results are odds ratios and 95%CI)

	Adolescent Age			
	10-11	12-13	14-15	16-17
Model				
Crude	1.56 (0.97-2.52)	1.10 (0.70-1.75)	0.91 (0.57-1.46)	0.91 (0.58-1.45)
Adjusted ¹	1.52 (0.92-2.50)	P.O.A.V. ^a	0.97 (0.60-1.55)	0.95 (0.58-1.56)
Adjusted ²	1.37 (0.83-2.26)	0.95 (0.58-1.56)	0.91 (0.55-1.49)	0.88 (0.54-1.46)

1. Adjusted for gender and SES
2. Adjusted for gender, SES, parent education and parent depression
 - a. The proportional odds assumption for the ordinal logistic regression analysis was violated. Multinomial logistic regression was used for the analysis.

Table 3.3 The relationship between ever having read to 2-3 year olds on a regular basis and adolescent depressive symptoms. (Results are odds ratios and 95%CI)

	Adolescent Age			
	10-11	12-13	14-15	16-17
Model				
Crude	0.93 (0.54-1.60)	1.48 (0.87-2.51)	1.15 (0.73-1.81)	1.43 (0.84-2.41)
Adjusted ¹	0.95 (0.55-1.63)	1.50 (0.87-2.58)	P.O.A.V. ^a	1.54 (0.91-2.60)
Adjusted ²	0.89 (0.52-1.51)	1.48 (0.85-2.55)	1.22 (0.75-2.01)	1.63 (0.91-2.92)

1. Adjusted for gender and SES
2. Adjusted for gender, SES, parent education and parent depression
 - a. The proportional odds assumption for the ordinal logistic regression analysis was violated. Multinomial logistic regression was used for the analysis.

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CHAPTER 4.0 GENERAL CONCLUSIONS AND DISCUSSION

4.1 SUMMARY

Two research studies were conducted on the subject of early cognitive development and its relationship to adolescent depression. The studies complemented each other in their use of a large, nationally representative cohort study of Canadian children and adolescents to answer questions about the etiology of depression. The questions are considered important because depression is currently the leading cause of disability worldwide.¹ It is also currently the seventh leading contributor to the global burden of disease.¹ Despite the high prevalence of depression, its causes and the relationships among causal factors remain unclear. Longitudinal approaches to researching depression are important because they could help to elucidate its etiology and help target public health interventions.

In the first project, the objectives were to investigate whether Canadian adolescents who had delay in attaining developmental milestones were more likely than those without delay to suffer from depressive and anxious symptoms in adolescence. A second objective was to investigate whether those adolescents who had delay in attaining developmental milestones were more vulnerable to depressive and anxious symptoms in adolescence after stressful life events. We found that children who had delay in attaining developmental milestones were more likely to suffer from depressive and anxious symptoms in adolescence. This is consistent with a study which found that delay in first standing and walking

were associated with depressive symptoms across the life course.² We did not find an interaction between stressful life events and delay in attaining developmental milestones.

In the second project, our first objective was to determine whether early impaired receptive vocabulary development was associated with adolescent depressive and anxious symptoms. The second objective was to determine whether impaired receptive vocabulary development at age 4-5 was associated with adolescent depressive and anxious symptoms after the occurrence of stressful life events. The third objective was to determine whether reading to young children on a regular basis was associated with reduced adolescent depressive and anxious symptoms. The last objective of this study was to determine whether reading regularly to young children with delayed developmental milestone attainment was associated with a larger decrease in depressive and anxious symptoms in adolescence compared to children who do not have delayed milestone attainment. Contrary to our expectations, we did not find any significant relationships in this study. However, these findings are consistent with authors who have hypothesized that there would not be a relationship between receptive vocabulary knowledge and depression³ because depressed adults do not perform worse on measures of verbal intelligence than non-depressed adults.^{4,5} We failed to find an association between early receptive language development and adolescent depression.

4.2 STRENGTHS AND LIMITATIONS

The results of these two studies broaden the knowledge base on the subject of cognitive development and depression. There are obvious practical and ethical considerations precluding a randomized control design for these particular studies. Children cannot be randomized to have delayed development. Additionally randomizing children to conditions where they experience different amounts of reading is unethical. The only viable option for a study design in this situation is an observational design. The prospective cohort study is less vulnerable to bias than other observational designs. The prospective cohort study provides good information on early developmental milestones and early language development. In the case of a retrospective design, some parents might have difficulty recalling this information. The risk of depression can also be measured directly with this design. Prospective cohort studies usually have the serious disadvantage of being very time consuming and expensive. However, the NLSCY has already collected all the data necessary for this study. As such, there are no concerns about excessive cost or time requirements for the current study.

The analyses performed relied on the use of data from the NLSCY collected by Statistics Canada. These data were not collected specifically for the purposes of our study. Therefore, these studies were subject to several limitations common to secondary data analysis. One limitation was the lack of control over the questions contained in the survey. Specifically, the studies did not have a clinical diagnosis of depression and relied on self-report of symptoms of depression. However,

recent findings suggest that subthreshold depressive disorders occur commonly in the population and produce significantly decreased health.⁶ By using the self-report measure of depressive symptoms, our studies may have the advantage of capturing some of these subthreshold depressive disorders. Another limitation related to the questions posed by the NLSCY pertains to the occurrence of stressful life events. For recent stressful life events in 10-15 year olds, parent report measures of stressful life events over the past two years or since the time of the last interview were used. This has two important limitations. First, in adolescence the median duration of a depressive episode is nine months.⁷ This means that by the time of the assessment of depressive symptoms, the potential increase in depressive symptoms after a stressful life event may have already passed (this is also relevant for self-reported stressful life events in 16-17 year olds). Second, parents may not be aware about potential school and peer-related stressful life events in a child's life. Hence, there may have been some misclassification in determining whether children had experienced a stressful life event.

Another limitation of our studies is the categorization of originally continuous data. As addressed in chapters 2 and 3, we used established cut-points. It was necessary to use cut-offs for the outcome variables (depressive symptoms) due to observed floor effects in the data. However, the main justification for dichotomizing exposure variables had to do with simplicity of interpreting results and defining individuals as exposed or unexposed as is common in

epidemiological studies. We acknowledge that although this makes interpretation simpler, we may have a loss of power and precision in our study results. There is also potential for residual confounding in instances where originally continuous potential covariates were categorized, such as the PMK depression covariate. However similar floor effects were observed for this variable so it was again necessary to group the variable. However, we acknowledge that our categorization of originally continuous variables is a limitation of these studies. Another limitation with our studies is that the NLSCY suffered considerable loss to follow-up. For the first study the percentage of participants remaining who were 2-3 years old in cycle 1 of the NLSCY by the follow-up period in cycle 6 was 62.96% and the percentage of participants remaining who were 2-3 years old in cycle 2 of the NLSCY by cycle 7 was 62.15%. Similarly, for the second study, the percentage of participants who responded to questions of interest in cycle 1 of the NLSCY who were 2-3 in cycle one and responded to self-report questions on depressive symptoms in cycle 5 were 57.87%, in cycle 6 64.60%, in cycle 7 60.13% and 47.52% in cycle 8. However, our study has attempted to correct for this limitation by the use of the longitudinal weights provided by Statistics Canada, which attempt to account for the loss to follow-up.⁸ Two types of bias can enter into the analysis due to non-response.⁸ First, had the non-respondents answered the questions, they may have answered the questions differently than those who responded to the survey. It is not possible to measure what these respondents would have answered. As such, this is one unavoidable limitation of the current study. However, one can attempt to account for the second bias

provided by non-response through the weights. The second bias is that the amount of non-response can bias the estimates if the non-respondents had significantly different characteristics than those who responded. However, the cycle-specific longitudinal weights are adjusted so that the respondents represent the non-respondents. In other words, more weight is put on respondents who are similar to non-respondents to account for demographic factors and ensure the sample is still representative of the Canadian population.⁸ Although the use of the weights attempts to reduce potential bias due to non-response, the procedure is based on assumptions and there still may be some bias present in the analysis because of non-response⁸ which is another limitation of the present study that must be accepted.

The use of weights provided by Statistics Canada cannot account for the problem of partial non-response.⁸ Certain respondents may have responded to some parts of the survey (so were included as respondents and assigned a longitudinal weight). However, they may not have responded to parts of the survey relevant to the current study. Some examples of reasons for partial non-response that were given as examples by Statistics Canada were “unwillingness to answer sensitive questions” and “respondent fatigue”.⁸ For example, it is possible that respondents who did not respond to questions on depressive and anxious symptoms may have answered the questions differently than those who responded. There is no way of knowing how these participants would have responded, so there is no way to account for this potential bias. However, this limitation is offset by the strength

that response rates were quite high for the self-report questionnaire (including the questionnaire on depressive and anxious symptoms). For 10-11 year olds in cycle 5 the component response rate for the self-complete questionnaire were 84.0%,⁹ for cycle 6 12-13 year olds 89.3%,¹⁰ for cycle 7 14-15 year olds 93.7%⁸ and for cycle 8 16-17 year olds 86.0%.¹¹ Although there is potential for bias due to partial non-response, there is also the advantage that partial non-response rates were low.

Selection bias can occur in a prospective cohort study if there is differential loss to follow-up. However, this was not present in our study. The missing data analyses indicated that subjects exposed to impaired early cognitive development (eg subjects delayed in attaining developmental milestones or with poor receptive vocabulary development) were not more likely to drop out than those who were unexposed. However, drop out was significantly related to income and parent education level. The highest percentage of drop-out for the income variable was for the lowest income category. The highest percentage of drop-out for PMK education was for the PMK having some education past high school but not yet having obtained a degree or diploma. This may threaten the generalizability of our study. We attempted to account for this with the use of longitudinal child weights provided by Statistics Canada which attempt to weight children who remain in the survey to represent those who do not.

There are also several non-sampling related biases that may be present in our study.⁸ For example, the interviewer may misread the question, the respondent may misunderstand the question or answer it incorrectly, or the data may be input improperly.⁸ As the true population response values are not known for the questions,⁸ it is difficult to account for this potential bias.

The limitations of the studies are offset by notable strengths, including the previously discussed prospective design spanning over a long time frame (from 1994/1995 to 2008/2009). Additionally, our studies had the strength of a large sample size, which was representative of the Canadian population.

4.3 DISCUSSION

The association we found between delayed in attaining developmental milestones and depression is small and is unlikely to be causal. Although it is known that an association should not always be ruled out as being causal on the basis of being small, the proposal that delay causes depression is not plausible. To the best of our knowledge, there is not an existing biological or social model to explain delayed development being causally related to depression. Additionally, we did not consistently find a significant association when we examined the relationship in two independent samples. More likely, delayed development is a risk factor related to an underlying cause of depression. Adolescent depression is a complex illness and there are likely to be many different causal pathways involving both biological and environmental factors that can lead to the development of this

illness. However, in the following section we propose one possible mechanism based on our research findings. This would need to be investigated in future studies that could also investigate potential causality.

Possible mechanism

The fetal programming hypothesis proposes that prenatal exposures determine susceptibility to disease later in life.¹² Hormone concentrations during pregnancy influence brain development. Exposure to corticosteroids *in utero* affects fetal brain development.¹² It has been suggested that this may affect health outcomes later in life. Adaptations to changes in the environment for adults are often reversible. However, for the growing fetus, they tend to be permanent.¹² Recent research has found an association between low birth weight and depression across the life course.² These authors have suggested that prenatal adversity may affect fetal neurodevelopment, permanently altering the stress response and laying the groundwork for poor mental health later in life.² The results of our research seem to be consistent with this reasoning. An early brain lesion or maldevelopment can become apparent in infancy as early cognitive milestones are slow to be reached in the months or years following birth.¹³ Our finding that delay in attaining developmental milestones is related to adolescent depressive symptoms suggest that an early life brain insult could be associated with adolescent depression. Further, our findings that reading to children from a young age, and that early receptive vocabulary development are unrelated to development of adolescent

depressive symptoms could suggest that the effects of such an early life insult may be specific to particular cognitive domains.

The corpus callosum is the largest tract of axonal fibres which connects the cerebral hemispheres, serving to integrate the activity of the two hemispheres and permitting communication between them.¹⁴ Damage to the white matter in the brain such as that found in the corpus callosum can occur from early life insults to the brain such as perinatal infection.¹⁵ Exposure to alcohol *in utero* is associated with structural abnormalities of the corpus callosum.¹⁶ This suggests that early life insults can cause damage to the corpus callosum.

Magnetic resonance imaging (MRI) techniques have determined that a large proportion of children with developmental delay have abnormalities in their corpus callosum.¹⁷ However, many children who have developmental delay have structurally normal brains.¹⁸ Recent research has used diffusion imaging techniques to examine children who have developmental delay but normal MRI results. This research determined that there are microstructural abnormalities present in the corpus callosum in children with developmental delay who have normal appearing brains.¹⁸ Microstructural abnormalities in the corpus callosum have also been linked to cognitive ability in adolescence.¹⁹

Studies of individuals who lack a corpus callosum (agenesis of the corpus callosum or AgCC) have been informative on cognitive abilities that may rely on this area of the brain. Perhaps the most thoroughly studied cognitive domain

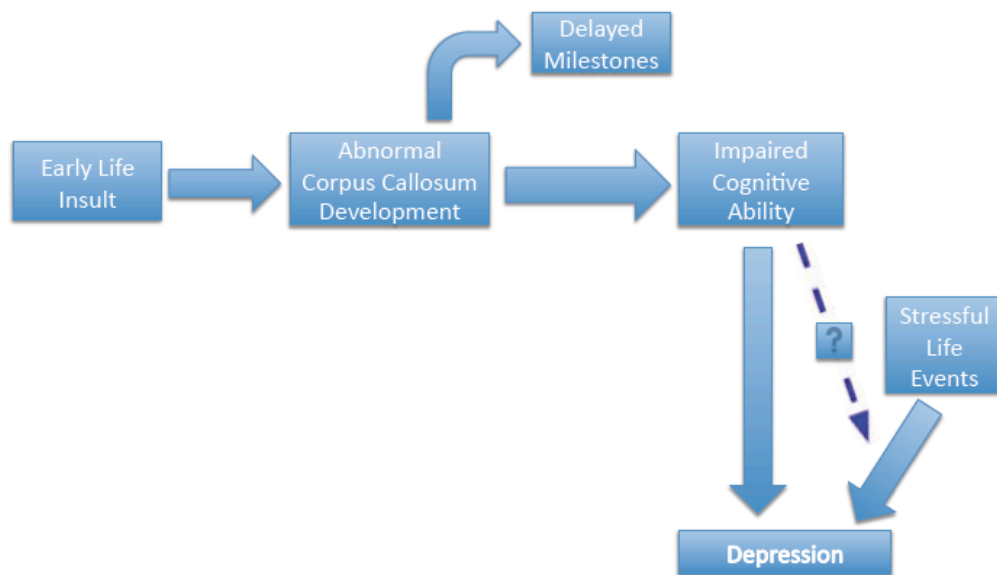
researched in AgCC patients is language. Studies have shown that individuals with AgCC have intact receptive language function.²⁰ This suggests that abnormalities in corpus callosum may not impact performance in tests of receptive language ability such as the PPVT-R used in our second study. If the relationship between delayed developmental milestones and adolescent depression were related to an abnormality of the corpus callosum, this could explain the null findings between the PPVT-R scores and adolescent depression found in our second study.

It has been observed that patients with AgCC share many behavioral and cognitive traits with individuals suffering from psychiatric disorders and this condition may be a powerful model for investigating mental illness.²⁰ Although most people suffering from psychiatric disorders are not missing their corpus callosum, previous authors have suggested that examining the similarities between AgCC and mental illness may help to discover which symptoms may be caused by problem in cortico-cortical connectivity.²⁰

Several neuroimaging studies have linked structural abnormalities in the corpus callosum to depression.^{21, 22} There is also suggestion that these brain abnormalities precede onset of depression as research has shown that abnormalities are present in the corpus callosum of healthy adolescents considered at high risk for developing depression due to family history of the illness.²³

Depression is a highly complex illness likely involving complex interactions of many factors. We acknowledge that we cannot infer causality from our research findings. However, one possible mechanism is postulated based on our findings depicted in figure 4.1.

Figure 4.1 Possible mechanism for adolescent depression



Based on our research findings, we suggest the possible mechanism for the development of adolescent depression shown in figure 4.1. An early life insult to the brain could result in abnormal corpus callosum development, and the observed delayed developmental milestones. Decreased microstructural integrity of the corpus callosum is associated with decreased cognitive ability in adolescence.¹⁹ Lower cognitive ability has been linked to the development of depression in several longitudinal studies.²⁴⁻²⁶ It may be that these individuals with impaired

cognitive ability resulting from abnormal development of the corpus callosum are less able to deal with stressful or negative stressful life events and may be more cognitively vulnerable to depression. Although the results of our study did not find an interaction between developmental delay and stressful life events, we still propose it as part of the mechanism because our methodological limitations (addressed in the limitations section of this chapter) and because the majority of evidence supports the stress-diathesis model of adolescent depression.²⁷ We propose that abnormal corpus callosum development results in specific impairments of cognitive ability, which make these individuals cognitively vulnerable to depression.

Public Health and Clinical Implications

We have demonstrated an association between delay in attaining developmental milestones and symptoms of anxiety and depression in adolescence. It could be beneficial for primary care physicians to provide anticipatory guidance regarding this association and to monitor or screen children with a history of developmental delay for depression in adolescence.

A recent systematic review concluded that early intervention programs (e.g. Headstart, Perry Preschool Program) are effective for preventing delay of cognitive development and promoting school readiness in at-risk children.²⁸ Further studies will be required to determine whether early intervention programs could decrease the incidence of adolescent depression among children with a

history of delayed developmental milestones. We found that reading in the home environment was not protective against adolescent depression. However, more intensive approaches such as early intervention programs might be able to decrease the incidence of depression in this at-risk population. Given the burden of disease associated with depression among adolescents and adults, such an intervention, if effective, could be a cost-effective public health strategy.

Future Research

Future research should investigate the relationship between delayed early development and depression after the occurrence of stressful life events using a more time specific measure and self-reported measure of stressful life events. As a result of the previously discussed limitations of our stressful life events questions and since the majority of evidence supports the stress-diathesis model of adolescent depression,²⁷ we hypothesized that stressful life events are still important for our relationship but failed to be captured by the questions used. However, further studies with more detailed data on stressful life events will be needed to confirm or dispute this proposed mechanism. It may be that an underlying neuropsychological deficit may be important for this particular pathway rather than the ability to cope after stressful life events. Further studies will be needed to investigate this area.

Future research should investigate potential resilience factors to the development of depression in children who experience developmental delay. As previously

noted, we failed to find a resilience factor in parents reading to their young children. It may be that more intensive formal programming such as early intervention is required for children who experience developmental delay. Future research should focus on different forms of early intervention to determine if this has any effect on resilience to adolescent depression.

Our study looked at only depressive and anxious symptoms. Future studies should look at the relationship between delayed development and depression in conjunction with other mental health conditions in order to determine unique factors associated with depression. This would generate hypotheses about etiology that is specific to depressive illnesses.

In addition, previous authors have stressed the importance of studying age of first onset of depression and the course of symptoms using a long-term perspective.²⁹

Age of onset could be an interesting and clinically relevant outcome.

Additionally, previous authors have stressed the importance of looking at trajectories of depressive symptoms.²⁹ They emphasize that examining depressive trajectories is important²⁹ given that the majority of depressed individuals recover over time.^{30, 31} Therefore, future research in this area should examine the relationship between impaired early cognitive development and age of onset of depression, as well as trajectories of depressive symptoms over time.

4.4 CONCLUSIONS

Our results suggest that early cognitive deficits precede the onset of adolescent depression. It will be important to continue research in this area. From a public health perspective, the elucidation of the etiologic factors related to early childhood cognitive development could help to identify children at risk of depression.

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APPENDIX

EMOTIONAL DISORDER ANXIETY SCALE (10-15 year olds)

There are three response options -“never or not true”, “sometimes or somewhat true”, or “often or very true”.

The seven items are:

- I am unhappy or sad
- I am not as happy as other people my age
- I am too fearful or nervous
- I worry a lot
- I cry a lot
- I am nervous, highstrung or tense
- I have trouble enjoying myself

DEPRESSION SCALE (16-17 year olds & PMK)

The question was phrased “How often have you felt or behaved this way during the past week?”

Response options included:

1. Rarely or none of the time (Less than 1 day)
2. Some or a little of the time (1-2 days)
3. Occasionally or a moderate amount of time (3-4 days)
4. Most or all of the time (5-7 days)

Questions included:

- I did not feel like eating; my appetite was poor.
- I felt that I could not shake off the blues even with help from my family or friends.
- I had trouble keeping my mind on what I was doing.
- I felt depressed.
- I felt that everything I did was an effort.
- I felt hopeful about the future

Nota: The values for this question were reversed for the calculation of the depression score.

- My sleep was restless
- I was happy

Nota: The values for this question were reversed for the calculation of the depression score.

- I felt lonely.

- I enjoyed life.

Nota: The values for this question were reversed for the calculation of the depression score.

- I had crying spells
- I felt that people disliked me.

STRESSFUL LIFE EVENTS (10-15 year olds)

In the longitudinal NLSCY cohort, the PMK for children 4 to 15 years of age was asked “In the past 2 years, has this child experienced any events or situations that caused him / her a great amount of worry or unhappiness?” If the answer to this question was yes, then the PMK was asked to indicate the cause.

Categories included:

- 1) Death of Parents
- 2) Death in Family
- 3) Divorce/Separation of Parents
- 4) Move
- 5) Death of Pet
- 6) Stay in Hospital
- 7) Stay in Foster Home
- 8) Other Separation from Parents
- 9) Illness/Injury of Child
- 10) Illness/Injury of Family Member
- 11) Abuse/Fear of Abuse
- 12) Change in Household Members
- 13) Alcoholism or Mental Health Disorder in Family
- 14) Other Traumatic Events

STRESSFUL LIFE EVENTS (16-17 year olds)

Youths aged 16-17 were asked “In the past two years, have you personally been through any of these events?”

Categories included:

- A painful breakup with a boyfriend or girlfriend
- A serious problem in school or at work
- A pregnancy or an abortion
- The death of someone close to you
- The divorce or separation of your parents
- Another difficult event

MOTOR AND SOCIAL DEVELOPMENT (MSD) SCALE

Children vary in the age at which they achieve developmental milestones. The following table depicts the MSD questions administered on the NLSCY and which age groups they are asked to. Additionally, it gives approximate ages we would expect to see these milestones being achieved. However, these values vary for different children. Questions 34-48 were administered to the 2-3 year old age group.

MSD Question	Motor and Social Development Scale Question	MSD Question Age Group(s)	Domain	Approximate Achievement Age
MSD-Q1	When lying on his/her stomach, has ... ever turned his/her head from side to side?	0-3 months	Posture and Large Movements ¹	1 Month ¹
MSD-Q2	Have his/her eyes ever followed a moving object?	0-3 months	Visual Perceptual and Fine Motor ¹	1 Month ¹
MSD-Q3	When lying on his/her stomach on a flat surface, has he/she ever lifted his/her head off the surface for a moment?	0-3 months	Gross Motor ²	3 months ²
MSD-Q4	Have his/her eyes ever followed a moving object all the way from one side to the other?	0-3 months	Visual Perceptual and Fine Motor ¹	3 months ¹
MSD-Q5	Has he/she ever smiled at someone when that person talked to or smiled at (but did not touch) him/her?	0-3 months	Social Behavior and Play ¹	5-6 weeks ¹
MSD-Q6	When lying on his/her stomach, has he/she ever raised his/her head and chest from the surface while resting his/her weight on his/her lower arms or hands?	0-3 months	Posture and Large Movements ¹	3 months ¹
MSD-Q7	Has he/she ever turned his/her head around to look at something?	0-3 months	Visual Perceptual and Fine Motor ¹	3 months ¹
MSD-Q8	When lying on his/her back and being pulled up to a sitting position, did ...	0-3 months 4-6 months	Posture and Large Movements ¹	3 months ¹

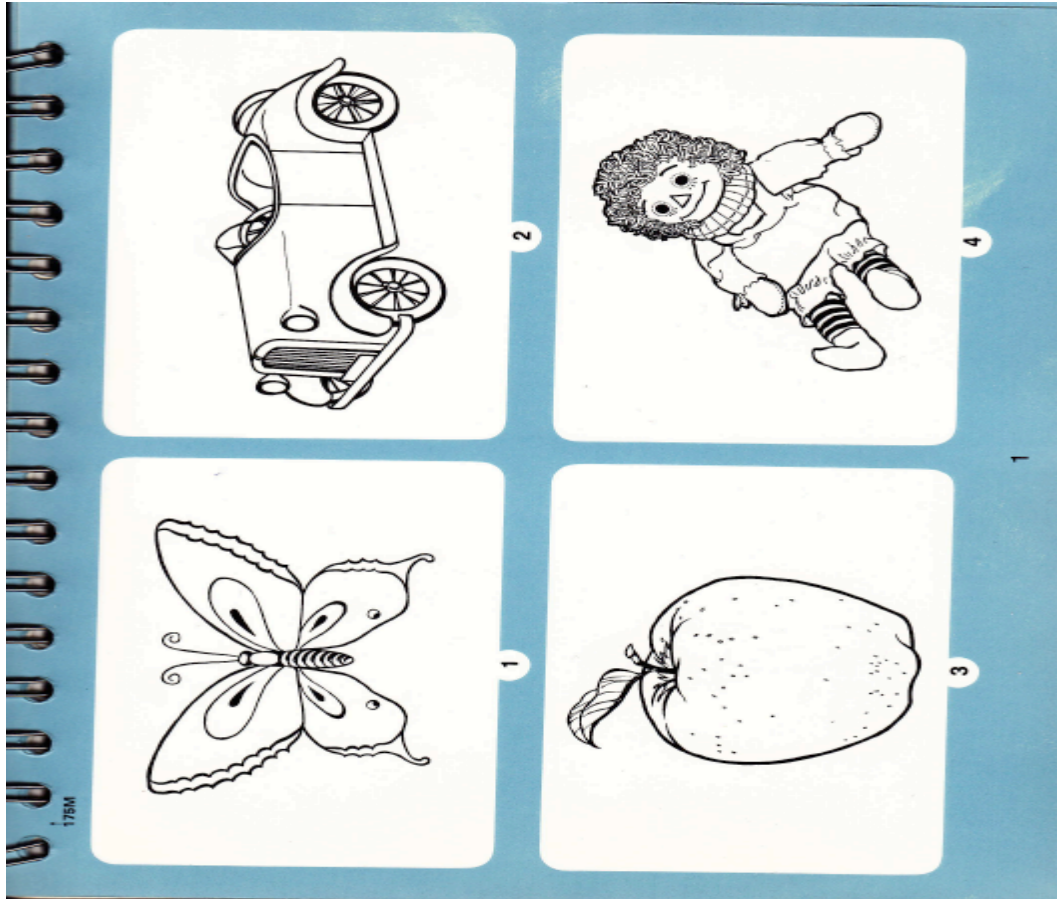
	ever hold his/her head stiffly so that it did not hang back as he/she was pulled up?			
MSD-Q9	Has he/she ever laughed out loud without being tickled or touched?	0-3 months 4-6 months	Speech Language and Communication ¹	6 months ¹
MSD-Q10	Has he/she ever held in one hand a moderate size object such as a block or a rattle?	0-3 months 4-6 months	Visual Perceptual and Fine Motor ¹	3 months ¹
MSD-Q11	Has he/she ever rolled over on his/her own on purpose?	0-3 months 4-6 months	Posture and Large Movements	5-6 months
MSD-Q12	Has ... ever seemed to enjoy looking in the mirror at him/herself?	0-3 months 4-6 months 7-9 months	Social and Emotional ²	7 months ²
MSD-Q13	Has he/she ever been pulled from a sitting to a standing position and supported his/her own weight with legs stretched out?	0-3 months 4-6 months 7-9 months	Gross Motor ²	7 months ²
MSD-Q14	Has he/she ever looked around with his/her eyes for a toy which was lost or not nearby?	0-3 months 4-6 months 7-9 months	Visual Perceptual and Fine Motor Development ¹	6 months ¹
MSD-Q15	Has he/she ever sat alone with no help except for leaning forward on his/her hands or with just a little help from someone else?	0-3 months 4-6 months 7-9 months	Posture and Large Movements ¹	6 months (supported) ¹ 5-9 months (independent sitting) ¹
MSD-Q16	Has he/she ever sat for 10 minutes without any support at all?	4-6 months 7-9 months	Posture and Large Movements ¹	5-9 months ¹
MSD-Q17	Has he/she ever pulled him/herself to a standing position without help from another person?	4-6 months 7-9 months	Posture and Large Movements ¹	9 months ¹
MSD-Q18	Has ... ever crawled when left lying on his/her stomach?	4-6 months 7-9 months 10-12 months	Posture and Large Movements ¹	9 months ¹
MSD-Q19	Has he/she ever said any recognizable words such as "mama" or "dada"?	4-6 months 7-9 months 10-12 months	Speech, Language and Communication ¹	12 months ¹
MSD-Q20	Has he/she ever picked up small objects such as raisins or cookie crumbs, using only his/her thumb and first finger?	4-6 months 7-9 months 10-12 months	Visual Perceptual and Fine Motor ¹	9 months ¹
MSD-Q21	Has he/she ever walked at least 2 steps with one hand held or holding on to something?	4-6 months 7-9 months 10-12 months	Posture and Large Movements ¹	12 months ¹

MSD-Q22	Has ... ever waved good-bye without help from another person?	4-6 months 7-9 months 10-12 months 13-15 months	Social Behavior and Play ¹	12 months ¹
MSD-Q23	Has he/she ever shown by his/her behavior that he/she knows the names of common objects when somebody else names them out loud?	7-9 months 10-12 months 13-15 months	Speech, Language and Communication ¹	12 months ¹
MSD-Q24	Has he/she ever shown that he/she wanted something by pointing, pulling, or making pleasant sounds rather than crying or whining?	7-9 months 10-12 months 13-15 months	Speech, Language and Communication ¹	15 months ¹
MSD-Q25	Has he/she ever stood alone on his/her feet for 10 seconds or more without holding on to anything or another person?	7-9 months 10-12 months 13-15 months	Posture and Large Movements ¹	12 months ¹
MSD-Q26	Has ... ever walked at least 2 steps without holding on to anything or another person?	7-9 months 10-12 months 13-15 months 16-18 months	Posture and Large Movements ¹	12 months ¹
MSD-Q27	Has he/she ever crawled up at least 2 stairs or steps?	10-12 months 13-15 months 16-18 months	Posture and Large Movements ¹	12 months ¹
MSD-Q28	Has he/she said 2 recognizable words besides "mama" or "dada"?	10-12 months 13-15 months 16-18 months	Speech, Language and Communication ¹	15 months ¹
MSD-Q29	Has ... ever run?	10-12 months 13-15 months 16-18 months 19-21 months	Posture and Large Movements ¹	18 months ¹
MSD-Q30	Has he/she ever said the name of a familiar object, such as a ball?	10-12 months 13-15 months 16-18 months 19-21 months	Speech, Language and Communication ¹	12 months ¹
MSD-Q31	Has he/she ever made a line with a crayon or pencil?	10-12 months 13-15 months 16-18 months 19-21 months	Visual Perceptual and Fine Motor ¹	15 months ¹
MSD-Q32	Did he/she ever walk up at least 2 stairs with one hand held or holding the railing?	10-12 months 13-15 months 16-18 months 19-21 months	Posture and Large Movements ¹	18 months ¹
MSD-Q33	Has he/she ever fed him/herself with a spoon or fork without spilling much?	13-15 months 16-18 months 19-21 months	Self-care and Independence ¹	18 months ¹
MSD-Q34	Has ... ever let someone know, without crying, that wearing wet (soiled) pants	13-15 months 16-18 months 19-21 months	Self-care and Independence ¹	18 months ¹

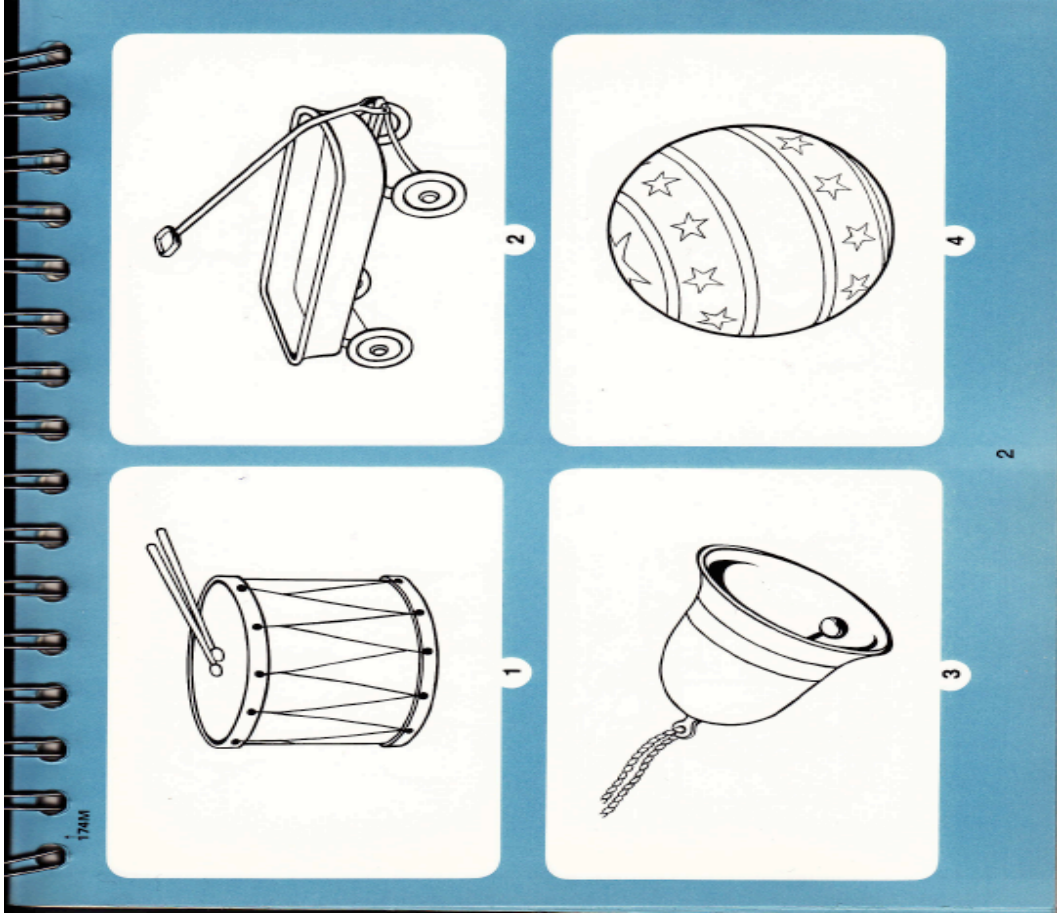
	or diapers bothered him/her?	22-47 months		
MSD-Q35	Has he/she ever spoken a partial sentence of 3 words or more?	13-15 months 16-18 months 19-21 months 22-47 months	Speech, Language and Communication ¹	18 months ¹
MSD-Q36	Has he/she ever walked up stairs by him/herself without holding on to a rail?	13-15 months 16-18 months 19-21 months 22-47 months	Posture and Large Movements ¹	3 years ¹
MSD-Q37	Has he/she ever washed and dried his/her hands without any help except for turning the water on and off?	16-18 months 19-21 months 22-47 months	Self-care and Independence ¹	3 years ¹
MSD-Q38	Has he/she ever counted 3 objects correctly?	16-18 months 19-21 months 22-47 months	Speech, Language and Communication ¹	3 years ¹
MSD-Q39	Has he/she ever gone to the toilet alone?	16-18 months 19-21 months 22-47 months	Self-care and Independence	18 months ³
MSD-Q40	Has he/she ever walked upstairs by him/herself with no help, stepping on each step with only one foot?	16-18 months 19-21 months 22-47 months	Posture and Large Movements ¹	3 years ¹
MSD-Q41	Does he/she know his/her own age and sex?	19-21 months 22-47 months	Speech, Language and Communication ¹	3 years ¹
MSD-Q42	Has he/she ever said the names of at least 4 colors?	19-21 months 22-47 months	Visual Perceptual and Fine Motor ¹	3 years ¹
MSD-Q43	Has he/she ever pedaled a tricycle at least 10 feet?	19-21 months 22-47 months	Posture and Large Movements ¹	3 years ¹
MSD-Q44	Has he/she ever done a somersault without help from anybody?	22-47 months	Posture and Large Movements ¹	5 years ¹
MSD-Q45	Has he/she ever dressed him/herself without any help except for tying shoes (and buttoning the backs of dresses)?	22-47 months	Self-care and Independence ¹	4 years ¹
MSD-Q46	Has he/she ever said his/her first and last name together without someone's help? (Nickname may be used for first name.)	22-47 months	Speech Language and Communication ¹	2 ½ years ¹
MSD-Q47	Has he/she ever counted out loud up to 10?	22-47 months	Speech, Language and Communication ¹	3 years ¹
MSD-Q48	Has he/she ever drawn a picture of a man or woman	22-47 months	Visual, Perceptual and	3 years ¹

	with at least 2 parts of the body besides a head?		Fine Motor ¹	
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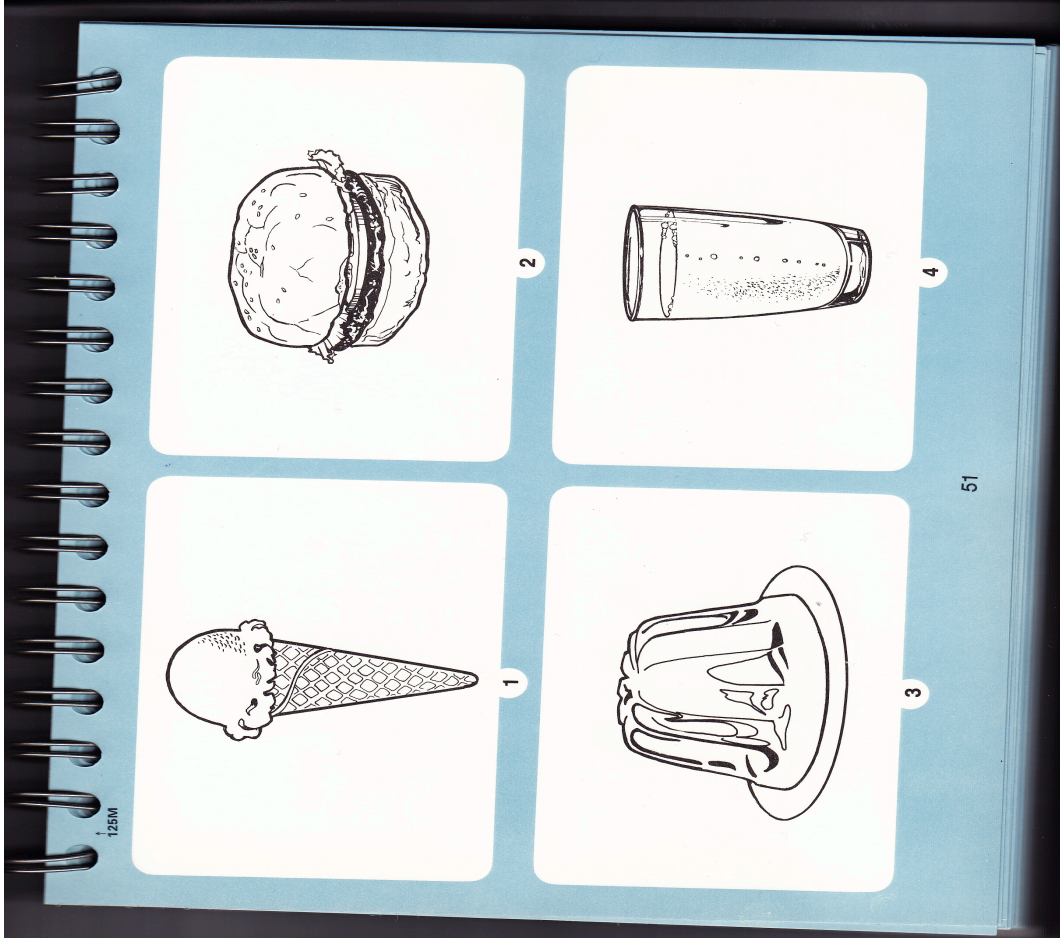
PEABODY PICTURE VOCABULARY TEST-REVISED (EXAMPLE CARDS)



Question: Car



Question: Ball



Question: Liquid

APPENDIX REFERENCES

1. Sheridan MD, Sharma A, Cockerill H. *From Birth to Five Years : Children's Developmental Progress*. 3rd ed. New York: Routledge; 2008.
2. American Academy of Pediatrics. *Caring for Your Baby and Young Child: Birth to Age 5*. 5th ed. New York: Bantam; 2009.
3. American Academy of Pediatrics. *Guide to Toilet Training*. New York: Bantam Books; 2003.