# EARLY CHILDHOOD DEVELOPMENT IN GRENADA: A NEURODEVELOPMENTAL SNAPSHOT OF CHILDREN AGED 3-5

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# EARLY CHILDHOOD DEVELOPMENT IN GRENADA: A NEURODEVELOPMENTAL SNAPSHOT OF CHILDREN AGED 3-5

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# PROJECT BACKGROUND AND PARTNERSHIP WITH UNICEF

The Saving Brains Grenada project began in 2014, as a pilot funded by Grand Challenges Canada (GCC) and re-funded by GCC in 2018 with transition to scale funds (TTS). The TTS requires matched funding, which UNICEF has provided in conjunction with other funding partners (i.e., US National Institutes of Health, Stanford University, USAID/Jhpiego). With the procurement of funding, the team developed and implemented a social innovation program aimed at child neurodevelopment, and child, parent, and teacher well-being. The original aim was to eliminate violence against children and maximize early child development by teaching alternative skills to adults with a focus on safety and connection as the basis of education and human capital development. The four components of the project are:

(1) A Saving Brains Bus and home visiting program for parents and caregivers, facilitated by a group of community intervention workers (Roving Caregivers).
(2) A coaching model for teachers and school staff, delivering a values-based training program (Conscious Discipline, Bailey, 2015) in Grenada pre-primary schools.
(3) An intervention for parents and young children aimed at rescuing neurodevelopment in children exposed to infectious diseases such as the Zika virus.
(4) A cross-sectional assessment of neurodevelopment in 3–5-year-olds in Grenada.

Component 4 provided for the development and implementation of an epidemiological assessment of neurodevelopment in 3–5-year-olds in Grenada, across at least 4 target domains: i) socioemotional, ii) language/communication, iii) motor, iv) attention/executive function (cognition). This involved the use of a commercially available, standardized assessment battery administered to 3-, 4-, and 5-year-old Grenadian children. Overall cohort performance is compared to a normative sample, providing a cross-sectional snapshot of child neurodevelopment in Grenada, and establishing a cohort for potential longitudinal studies. The methodology will be replicable in other OECS countries in the future.

# SAMPLE CHARACTERISTICS

A total of 514 children aged 3-5 across Grenada were assessed for this report. There was a near even split between males and females.

| Age | N | Gender |
|---|---|---|
| 3 | 212 | 46.2% Female, 53.8% Male |
| 4 | 193 | 48.2% Female, 51.8% Male |
| 5 | 109 | 46.8% Female, 53.2 % Male |

Table 1. *Age and Gender Breakdown of Sample*

# METHODOLOGY

*Assessment*

All children in this report were assessed using "A Developmental NEuroPSYchological Assessment" (NEPSY-II) measure, (Korkman, Kirk & Kemp, 2007). The NEPSY-II contains 32 subtests divided into the six domains of neurodevelopment: (1) Attention and Executive Function, (2) Language, (3) Memory and Learning, (4) Sensorimotor, (5) Social Perception, and (6) Visuospatial Processing. The NEPSY-II is suitable for children ages 3-16. The NEPSY-II allows for the administration of flexible test batteries depending upon the age of the child and purpose of assessment. Some subtests measure multiple domains.

1) The **Attention and Executive Function** domain is centered around self-regulation. Executive functions include working memory, planning, flexible thinking, and self-control, while attention refers to the ability to retain focus on a specific stimulus. These two aspects of functioning and development have some overlap and are commonly presented together. We assessed executive function using the Statue subtest.
2) The **Language** domain explores the child's ability to express and understand verbal communication. We assessed language using Comprehension of Instructions, Speeded Naming and Word Generation subtests.

3) The **Memory and Learning** domain assesses verbal memory span, short-term memory, and the child's ability to efficiently encode auditory information into working memory. We assessed memory and learning using the Sentence Repetition subtest.
4) The **Sensorimotor** domain may include fine motor and gross motor functioning, but the NEPSY-II focuses primarily on fine motor speed and coordination. This is demonstrated by the capacity to control hand movements with precision and with relative ease. Tasks that require fine motor skills are writing and drawing as well as activities of daily living such as manipulating objects, dressing oneself, etc. We assessed Sensorimotor functioning using Imitating Hand Positions and Visuomotor Precision subtests.
5) **Social perception** is necessary for understanding social information, cues, and non-verbal communication, such as recognizing emotions. We assessed Social Perception using the Affect Recognition and Theory of Mind subtests.
6) **Visuospatial Processing** has multiple components including the ability to discriminate between objects, to synthesize elements into a meaningful whole, and to represent objects mentally. We assessed Visuospatial Processing using the Block Construction subtest.

For the purposes of this snapshot, at least one subtest was used to evaluate performance on each of the six domains. Ten subtests for 3–5-year-olds were selected, which covered all domains of functioning, as previously assessed in Grenadian children using the OX-NDA and INTER-NDA (Fernandes, 2014).

(1) **Affect Recognition** assesses a child's ability to recognize common facial expressions of emotion. The child is asked to determine and compare expressions on children's faces.
(2) **Block Construction** determines whether a child can use blocks to build exact models based on two-dimensional drawings.
(3) **Comprehension of Instructions** determines a child's ability to process and respond to verbal instructions by choosing the appropriate item. The child is asked to select one of the items on the page, based on its characteristics.
(4) **Imitating Hand Positions** is a fine motor task that determines whether a child can imitate different hand and finger positions shown by the researcher.

(5) Sentence Repetition assesses the child's ability to repeat sentences of increasing difficulty and length.
(6) Speeded Naming assesses the child's ability to identify and name colours, shapes, sizes, letters, or numbers as quickly as they can. The child follows diagrams on the page, and names them one by one on a timed trial.
(7) Statue assesses the child's capacity to maintain a position and control the impulse to respond to distractors. The child stands still like a "statue" with their eyes closed while the researcher tries to distract them with.
(8) Theory of Mind tests the child's ability to imagine and understand another person's perspective and their ability to understand mental functions like intention, deception, and imagination by listening to a question, a story or looking at a picture.
(9) Visuomotor Precision assesses the child's ability to draw within the lines of a straight or curved track as quickly as they can. Both precision and speed are measured.
(10) Word Generation evaluates the child's ability to retrieve and produce vocabulary, working memory, processing speed, and attention. The child is given a specific category and is asked to name as many words (in one minute) in that category as possible.

It is important to note that these tests were normed on a representative sample of North American children in 2007. They have not been normed in the English-speaking Caribbean. As such, the scaled scores may not be an accurate representation of the assessed children's capabilities. The short and long-term implications of children scoring below the expected range on any of these subtests is not known in the English-speaking Caribbean. Furthermore, low scores on subtests in any domain do not necessarily indicate developmental delays. Rather, further assessments should be carried out to investigate patterns of deficient performance in other environments and should be collated with interviews with parents and teachers as well as observations in everyday settings.

*Recruitment*

For this snapshot report children between the ages of 3-5 were recruited from two ongoing surveillance research studies in Grenada. Parents were contacted by phone and invited to participate in this current assessment. If they agreed to participate, the research team travelled to the child's school or home to administer the NEPSY-II. The initial target sample was N=600 children; however, due to the COVID-19 pandemic and country/school lockdowns, 86% of those assessments were completed (N=514).

*Data Collection*

Between June 2019 and August 2021, single timepoint assessment data was collected on n=212 3-year-olds, n=193 4-year-olds, and n=109 5-year-olds. Assessments were carried out by a team of eight trained research assistants with extensive experience carrying out neurodevelopmental assessments of young children.

# FINDINGS AND INTERPRETATIONS

To interpret the neurodevelopmental assessments of young children included in this report, it is helpful to understand the normative bell curve. For most phenomenon being measured, values are expected to fall on a curve, in which most observations will fall in the middle, while fewer and fewer observations will fall on the left (lower value) and right (higher value) the more extreme the observed value is (Figures 1 and 2).

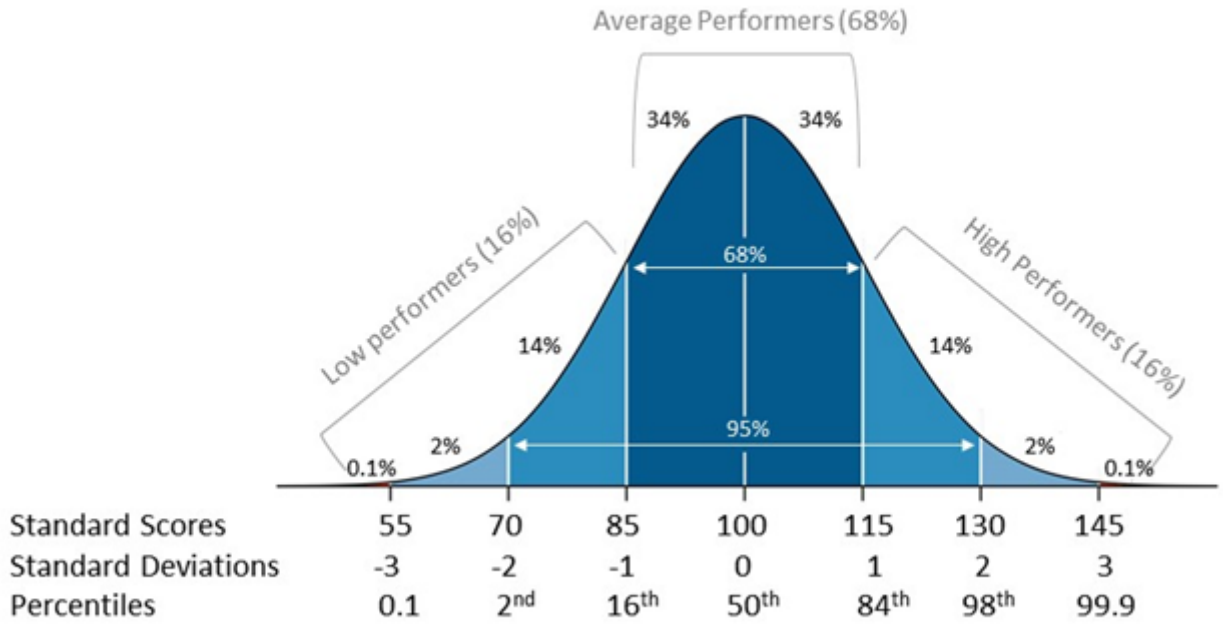


Figure 1. *Normative Bell Curve. This figure provides percentages of examinees expected to fall in any given performance range. For instance, many examinees (68%) will fall in the "At Expected Level" (see below). In a normal population, approximately 16% should fall in the "Above Expected," or high performance" levels, and 16% should fall in the "Below Expected," or "low performance" levels.*

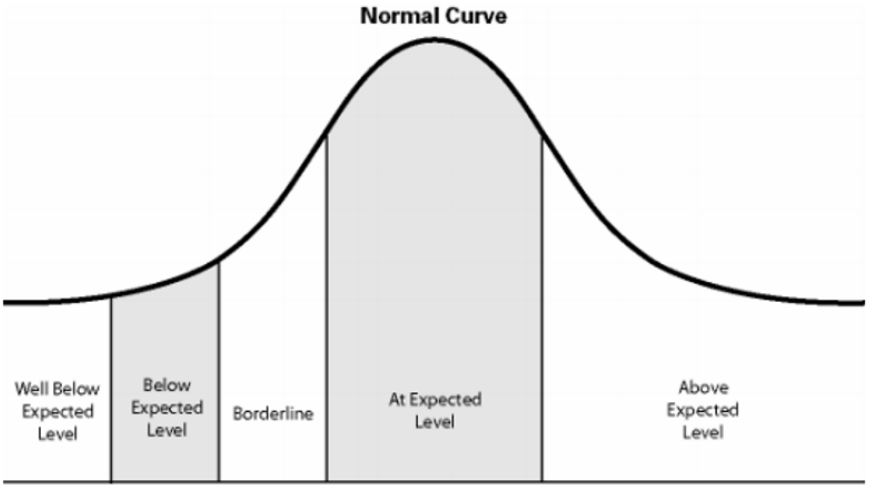


Figure 2. *This shows the same Normative Bell Curve, with terminology used throughout this report. According to a normative curve, 84% of examinees should fall in the At Expected or Above Expected Levels, and 16% should fall in the Borderline, Below, or Well Below Expected Levels.*

Results indicate that most children are performing at expected levels for their age groups (Figures 3-5).

Figures 3a-f. *Charts Indicating 3-Year-Old Performance on the Six Domains of the NEPSY-II*

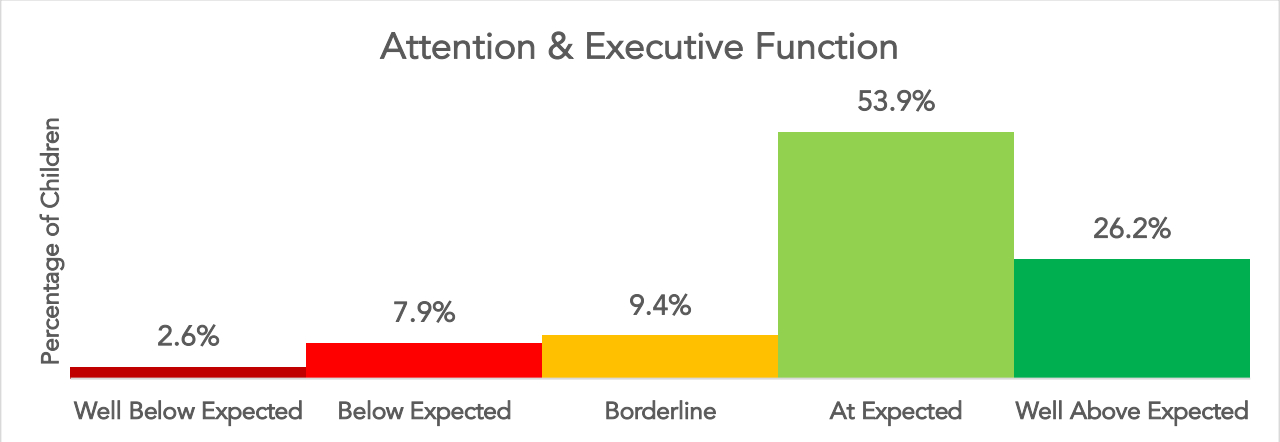


Figure 3a. *3-Year-Old Performance on Attention & Executive Function Subdomain*

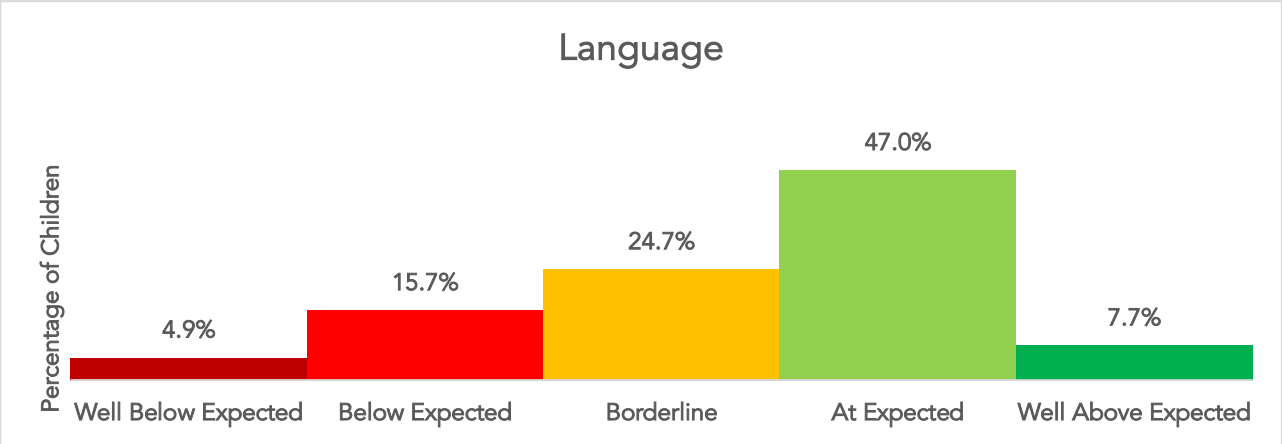


Figure 3b. *3-Year-Old Performance on Language Subdomain*

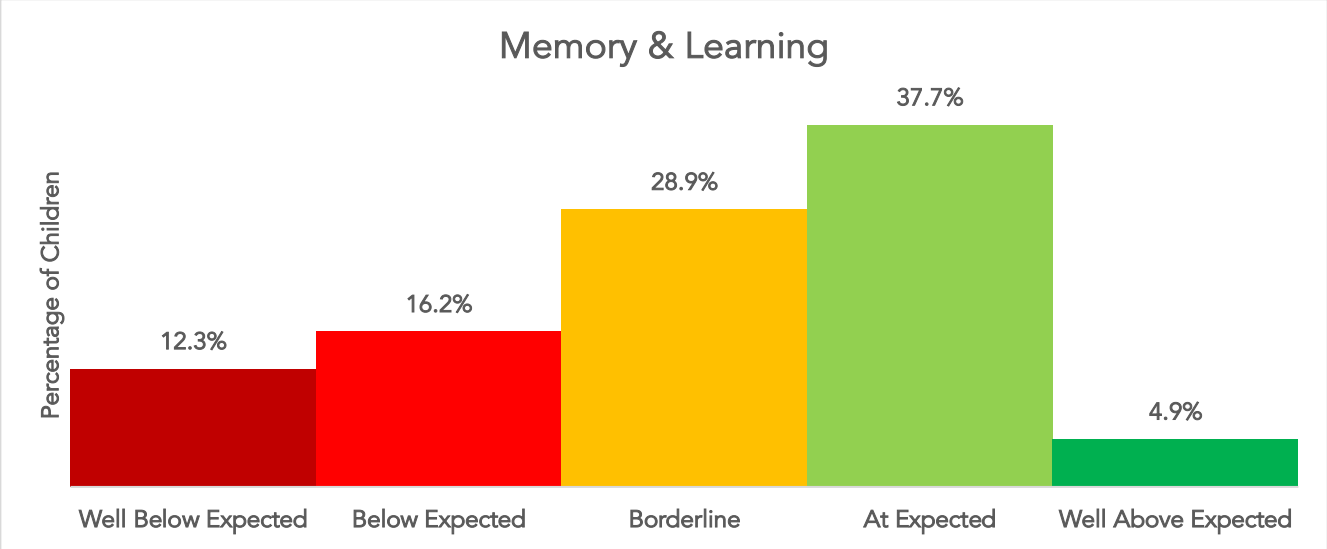


Figure 3c. *3-Year-Old Performance on Verbal Memory & Learning Subdomain*

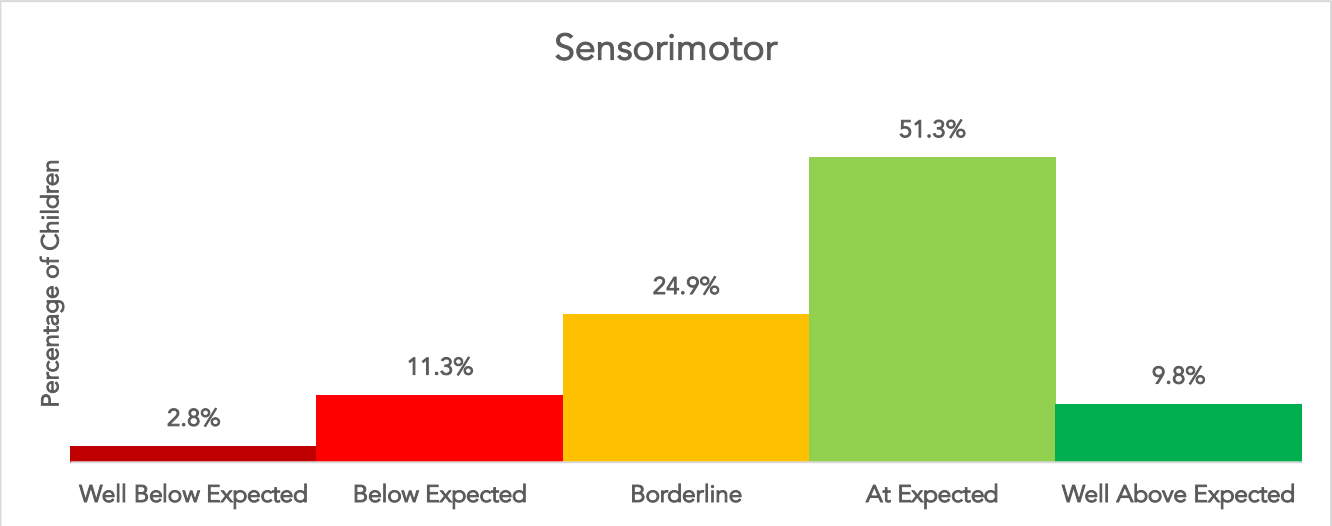


Figure 3d. *3-Year-Old Performance on Sensorimotor Subdomain*

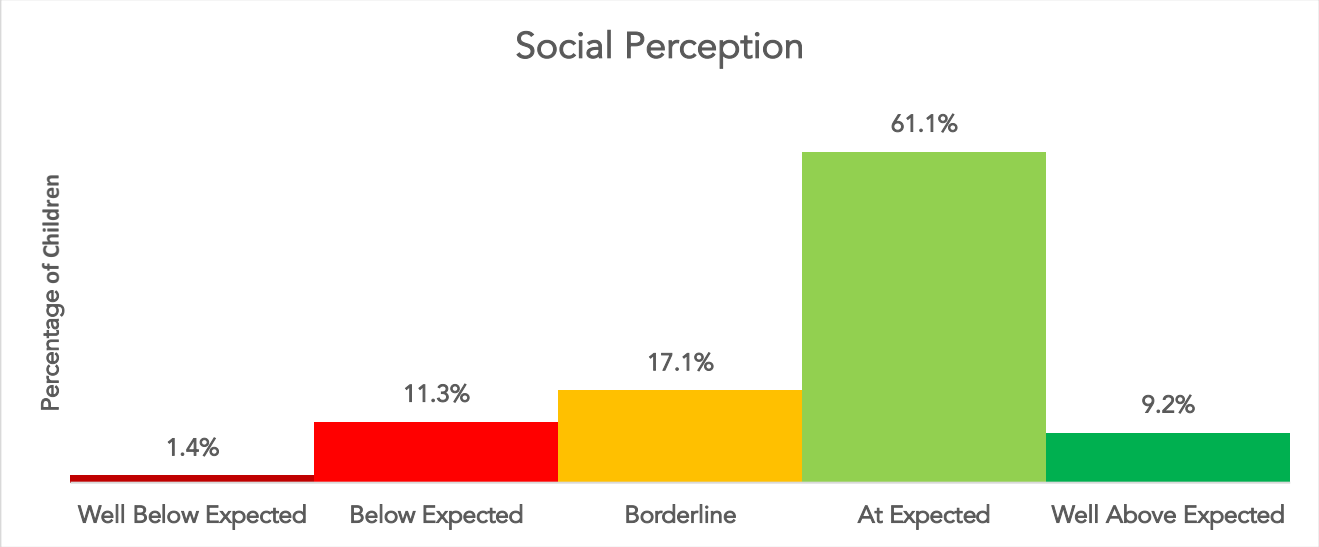


Figure 3e. *3-Year-Old Performance on Social Perception Subdomain*

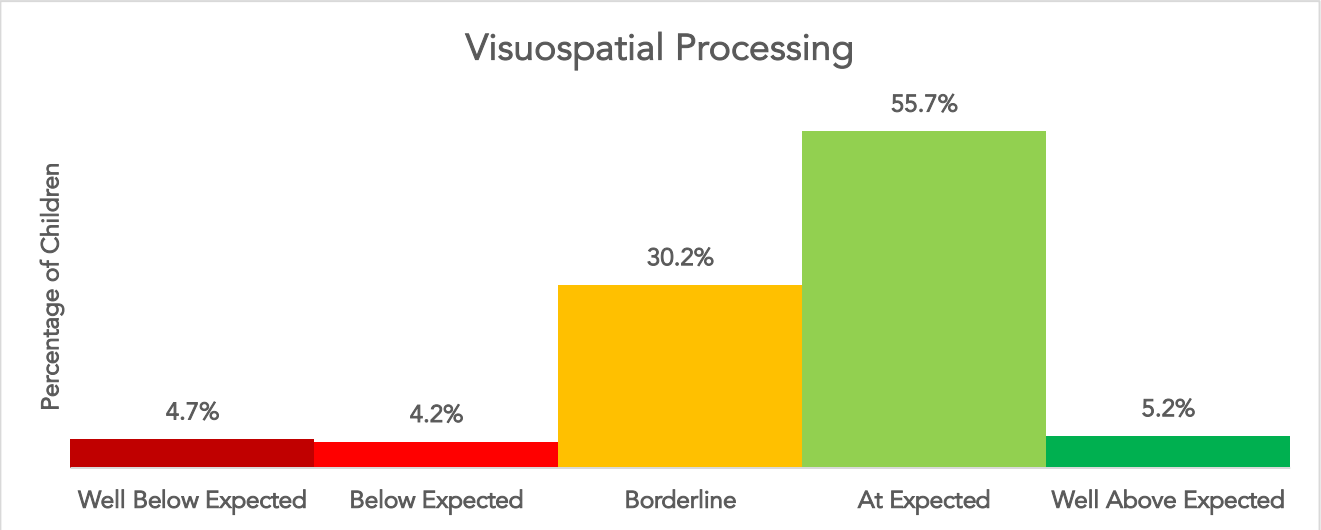


Figure 3f. *3-Year-Old Performance on Visuospatial Processing Subdomain*

Figures 4a-f. *Charts Indicating 4-Year-Old Performance on the Six Domains of the NEPSY-II*

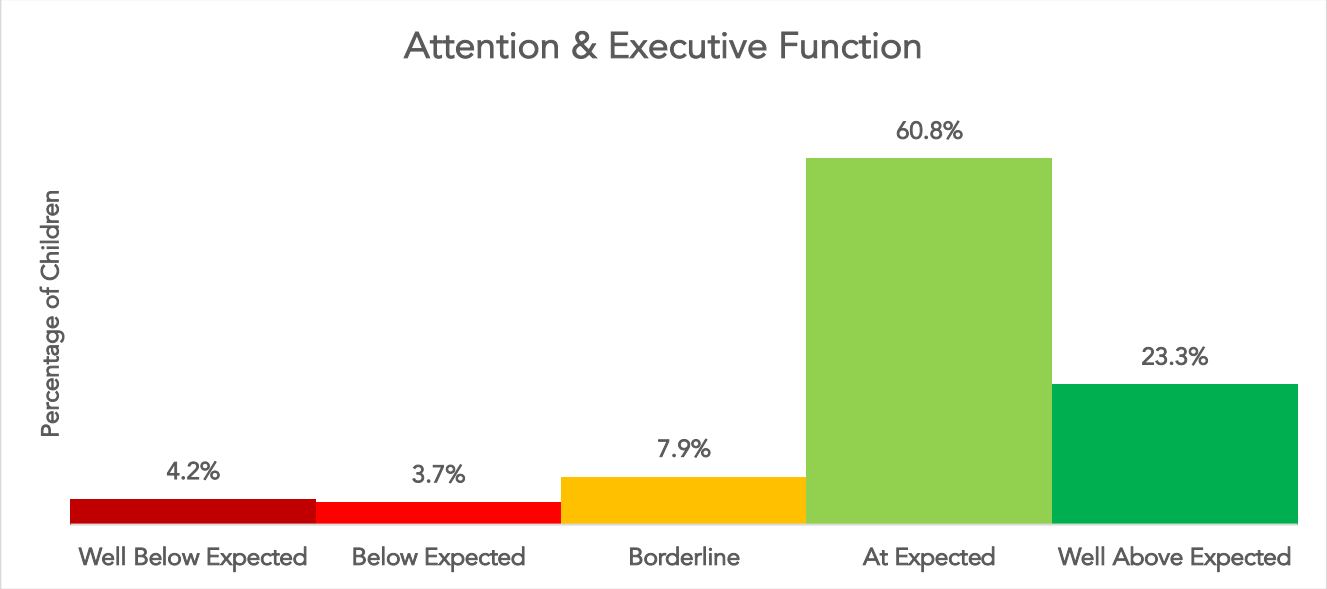


Figure 4a. *4-Year-Old Performance on Attention & Executive Function Subdomain*

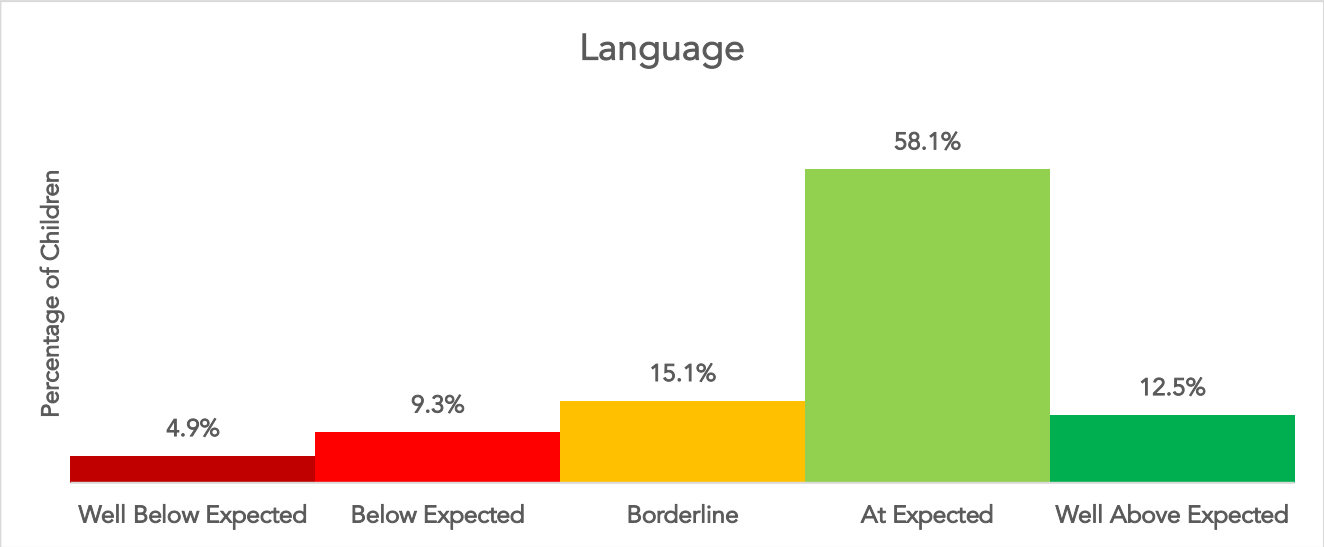


Figure 4b. *4-Year-Old Performance on Language Subdomain*

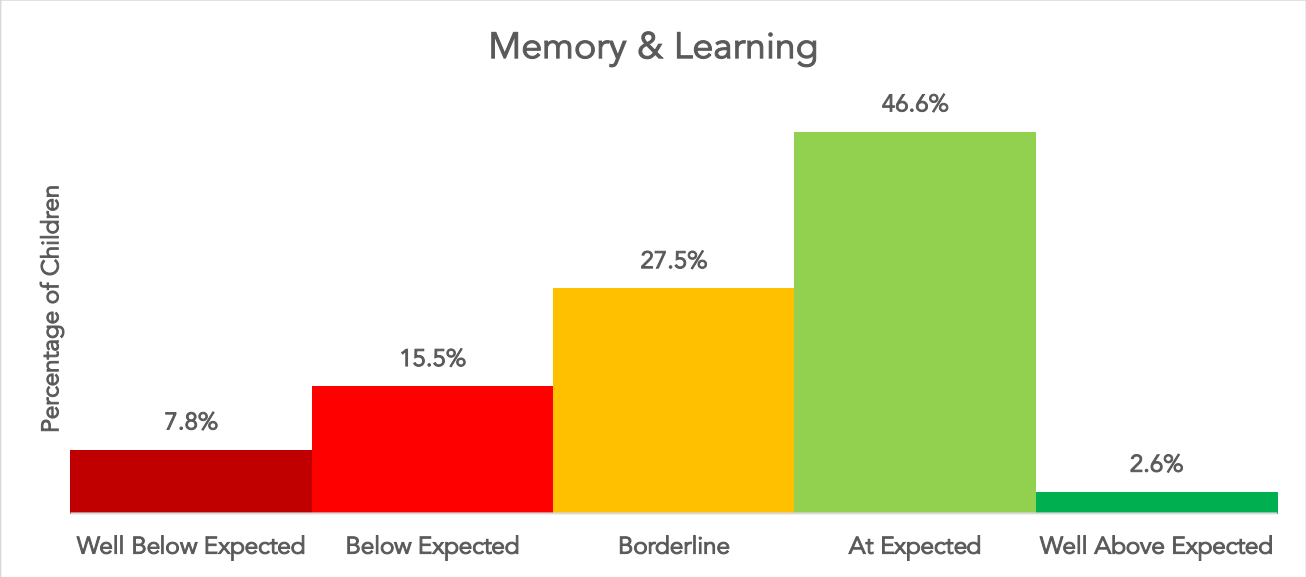


Figure 4c. *4-Year-Old Performance on Verbal Memory & Learning Subdomain*

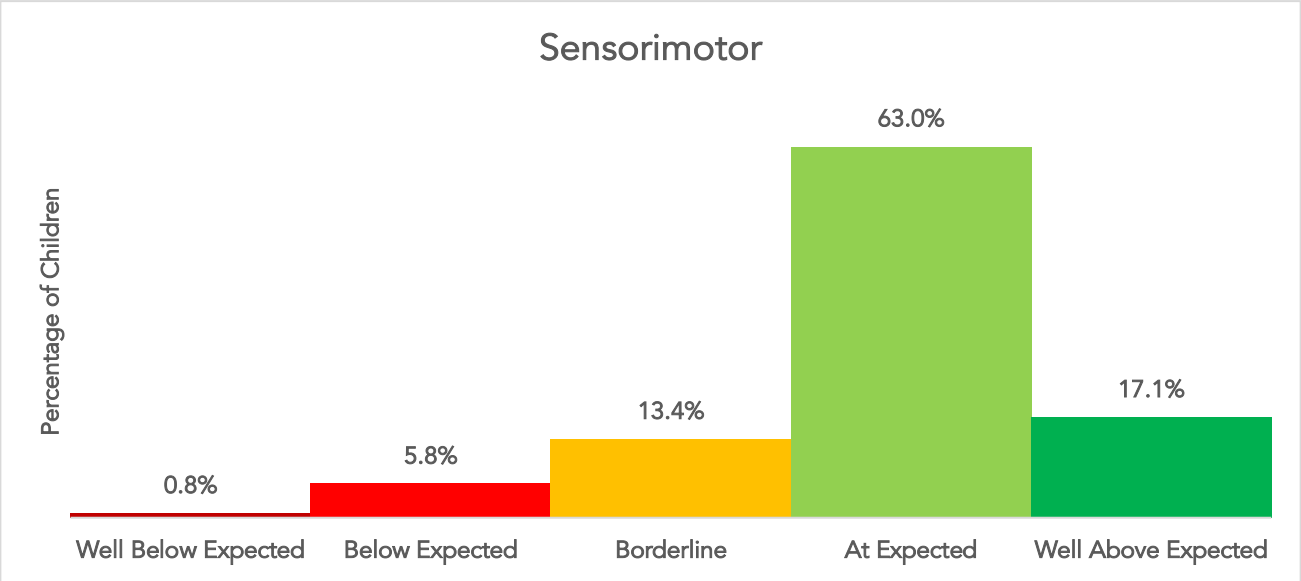


Figure 4d. *4-Year-Old Performance on Sensorimotor Subdomain*

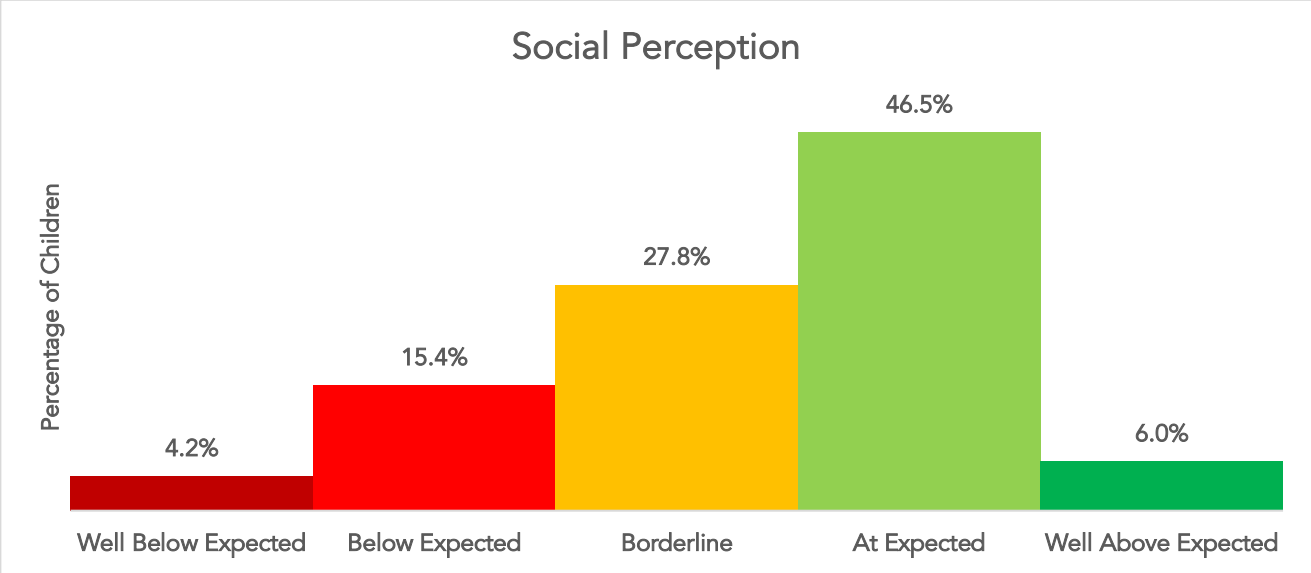


Figure 4e. *4-Year-Old Performance on Social Perception Subdomain*

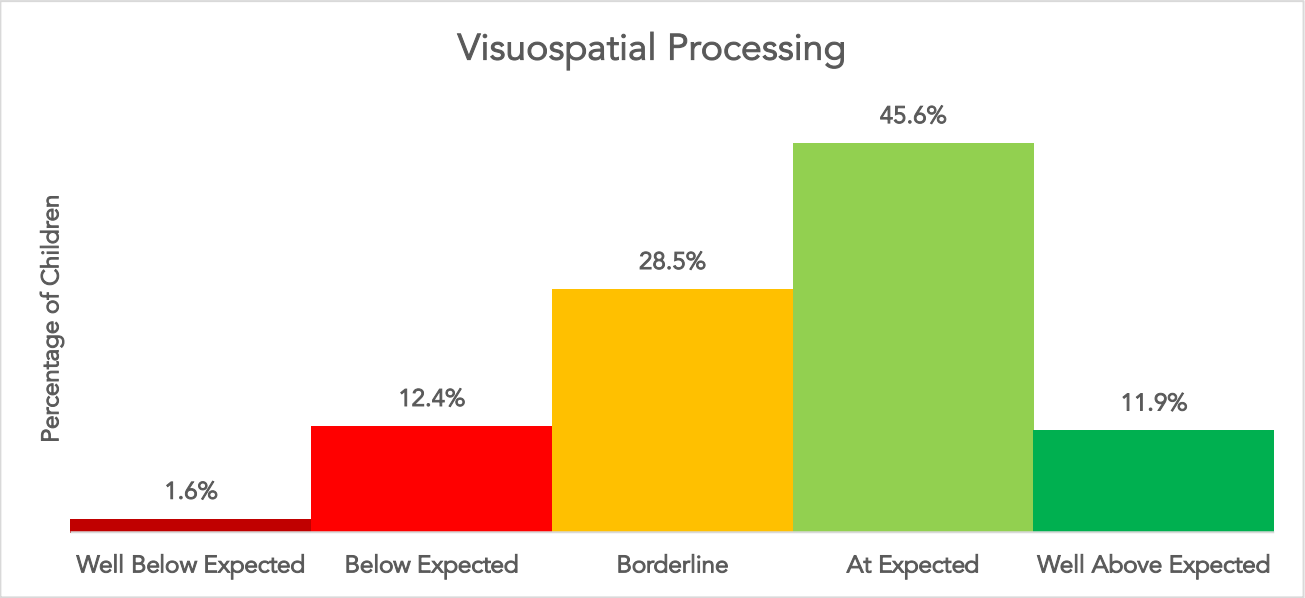


Figure 4f. *4-Year-Old Performance on Visuospatial Processing Subdomain*

Figure 5a-f. *Charts Indicating 5-Year-Old Performance on the Six Domains of the NEPSY-II*

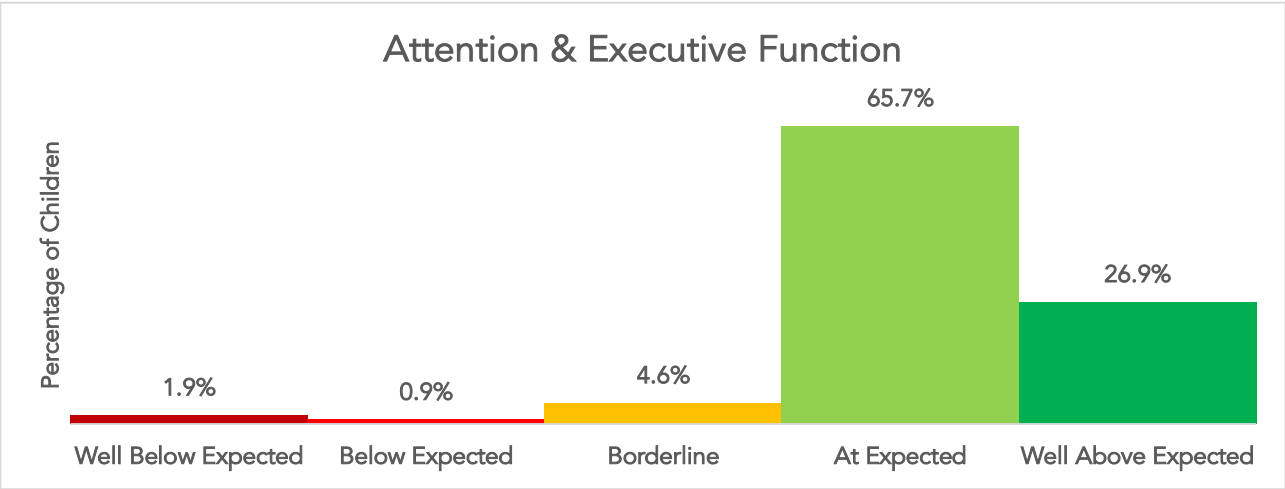


Figure 5a. *5-Year-Old Performance on Attention & Executive Function Subdomain*

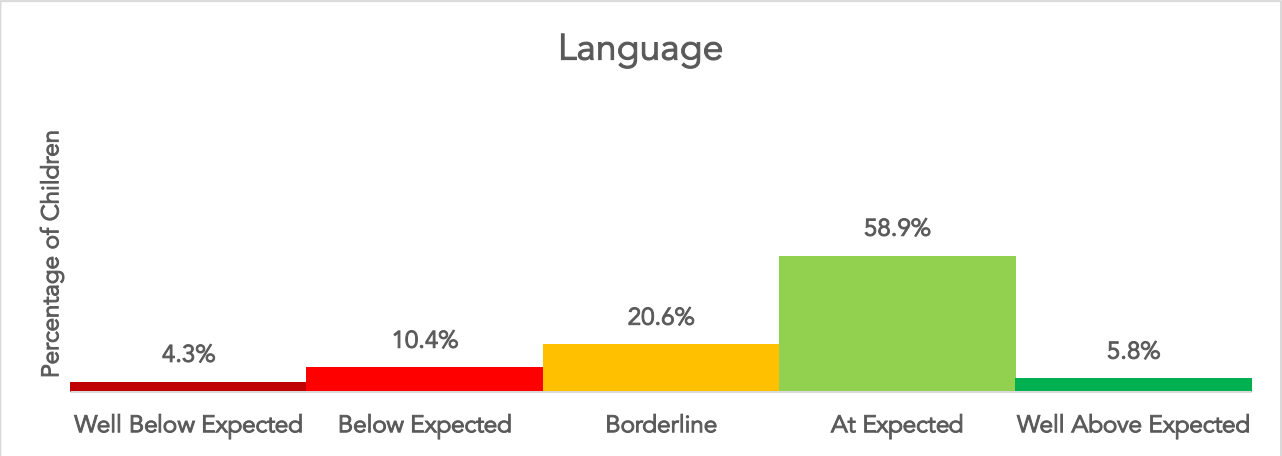


Figure 5b. *5-Year-Old Performance on Language Subdomain*

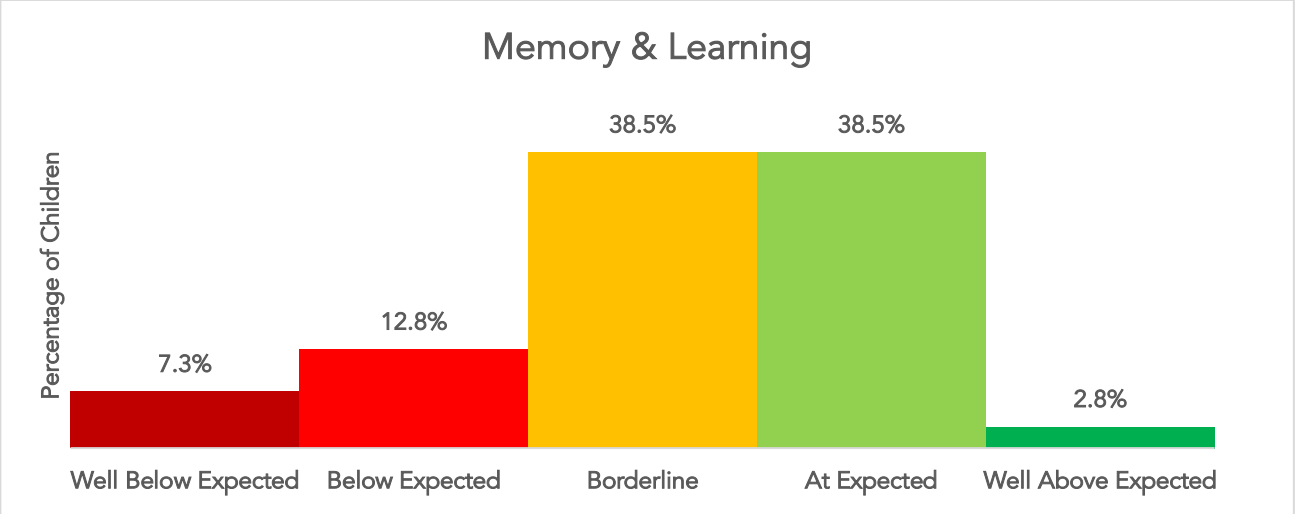


Figure 5c. *5-Year-Old Performance on Verbal Memory & Learning Subdomain*

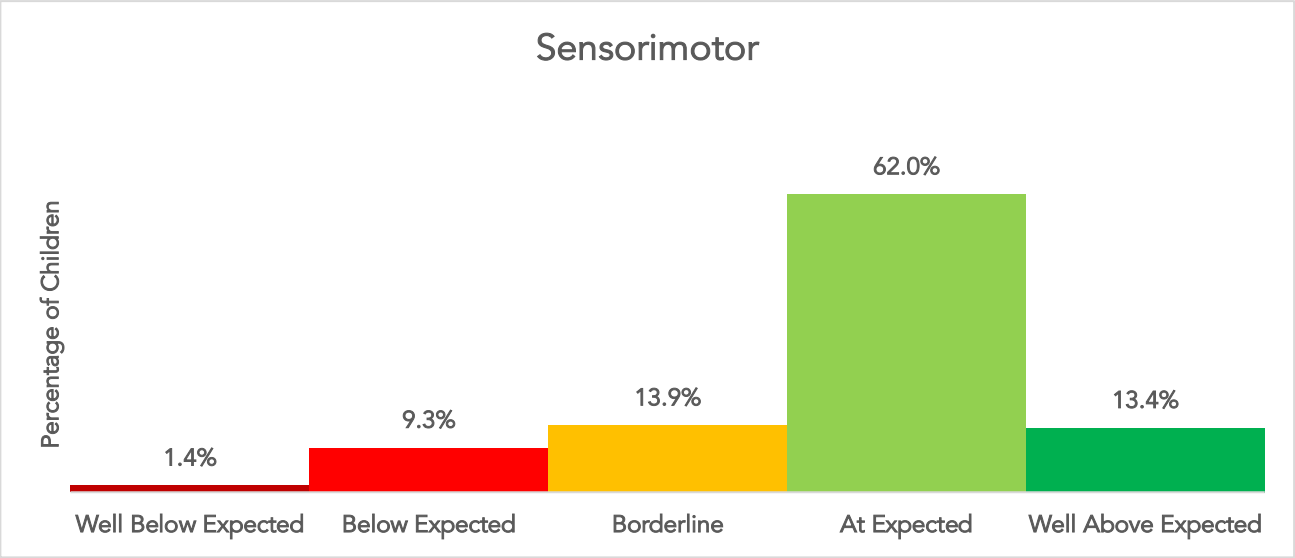


Figure 5d. *5-Year-Old Performance on Sensorimotor Subdomain*

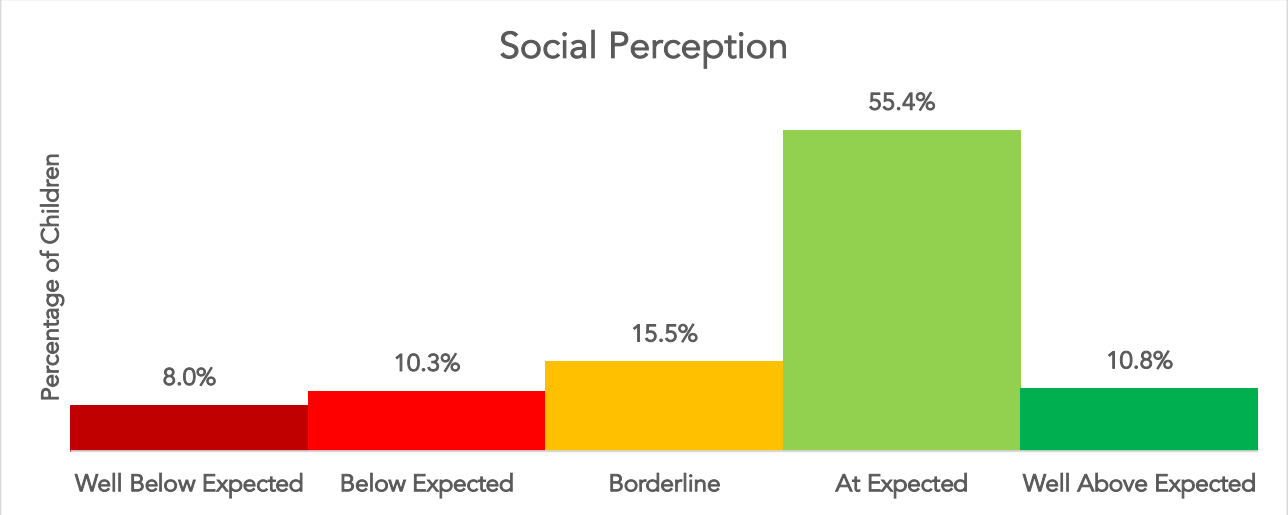


Figure 5e. *5-Year-Old Performance on Social Perception Subdomain*

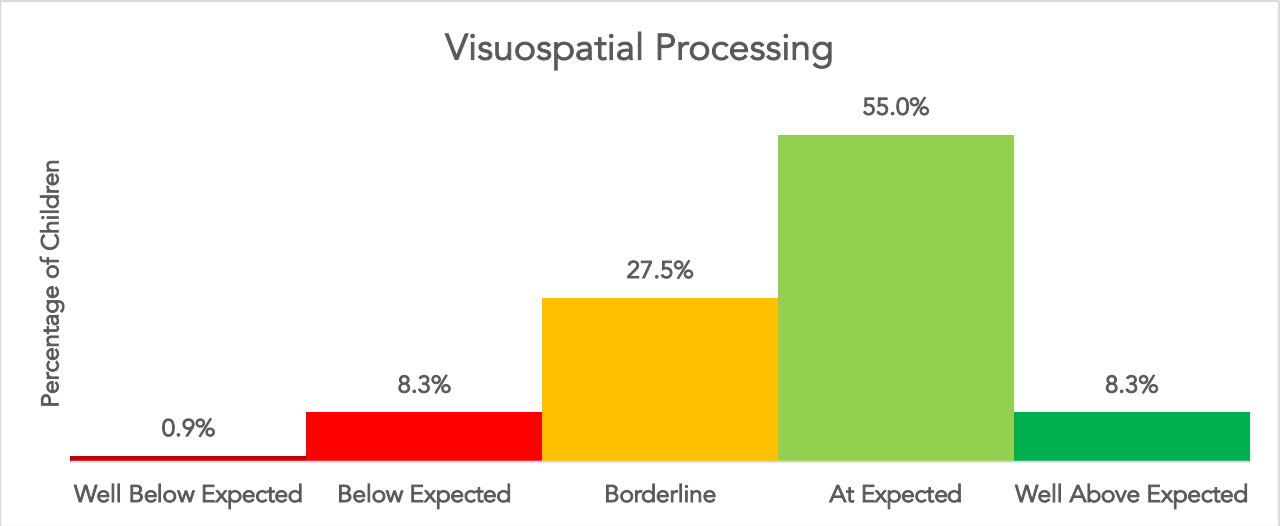


Figure 5f. *5-Year-Old Performance on Visuospatial Processing Subdomain*

| Domain | % Below Expected Range (Below Expected Level & Well Below Expected Level) | | | |
|---|---|---|---|---|
| | 3-Year-Olds | 4-Year-Olds | 5-Year-Olds | Average |
| Attention and Executive Functioning | 10.5 | 7.9 | 2.8 | 7.1 |
| Language | 20.6 | 14.2 | 14.7 | 16.5 |
| Memory and Learning | 28.5 | 23.3 | 20.1 | 24.0 |
| Sensorimotor | 14.1 | 6.6 | 10.7 | 10.5 |
| Social Perception | 12.7 | 19.6 | 18.3 | 16.9 |
| Visuospatial Processing | 8.9 | 14.0 | 9.2 | 10.7 |
| Average | 15.9 | 14.3 | 12.6 | |

Table 2. *Percentage of Children Scoring Below and Well Below Expected Levels on the NEPSY-II*

| Domain | % Above Expected Range (At Expected Level & Well Above Expected Level) | | | |
|---|---|---|---|---|
| | 3-Year-Olds | 4-Year-Olds | 5-Year-Olds | Average |
| Attention and Executive Functioning | 80.1 | 84.1 | 92.6 | 85.6 |
| Language | 55.4 | 70.6 | 64.7 | 63.6 |
| Memory and Learning | 42.6 | 49.2 | 41.3 | 44.4 |
| Sensorimotor | 61.1 | 80.1 | 75.4 | 72.2 |
| Social Perception | 70.3 | 52.5 | 66.2 | 63.0 |
| Visuospatial Processing | 60.9 | 57.5 | 63.3 | 60.6 |
| Average | 61.7 | 65.7 | 67.3 | |

Table 3. *Percentage of Children Scoring At and Well Above Expected Levels on the NEPSY-II. In a normally distributed sample, 84% of children should be At or Above Expected Levels; in other words, scoring between the 37$^{th}$ and 99.9$^{th}$ percentiles. As one can see from the table, this was not the case in several domains among our sample of Grenadian children.*

*COVID-19 Analysis*

To determine whether the COVID-19 pandemic is negatively impacting early child development, children who were assessed prior to the pandemic (June 2019 – February 2020) were compared to children who were assessed following the pandemic (March 2020 – August 2021) and associated lockdowns. The pre-pandemic group consisted of n=261 children and the post-pandemic group consisted of n=253 children. After a correction for multiple comparisons, analysis indicated no significant difference in NEPSY performance scores in children before and during the COVID-19 pandemic through June 2021. It is important to note that these assessments might not capture the impact of the COVID-19 pandemic and associated lockdowns on early child development. Further follow-up and longitudinal studies are needed to track early child development in these children with a particular focus on developmental outcomes between children who have had access to remote learning technologies versus children who have not had access to these technologies.

# DISCUSSION

We assessed 514 children aged 3 to 5 in the 27 months between June 2019 and August 2021. The following observations are relevant to the purpose of this snapshot study, which was to establish a neurodevelopmental baseline of a representative sample of Grenadian children. To our knowledge, this study is the first of its kind in the region to examine whether Caribbean children are performing at expected levels across developmental domains: language, cognition, motor skills, and social emotional functioning. The results of our assessment indicate the following:

- Given that 84% of children should fall within At Expected or Above Expected Levels, there *appear* to be some cumulative delays in all domains except Executive Functioning (which was assessed only by the Statue subtest), and most notably in the domain of Memory and Learning. Cumulative scores did not approach 84% in all domains, though more older children than younger children were At or Above Expected Levels, likely suggesting that both school attendance and normal processes of growth and development improve children's skills over time and across domains. It is extremely important to note that because these scores are not based on a normative sample of Caribbean children, the categories "Borderline," "Below Expected Levels," and "Well Below Expected Levels" may not be valid in this context.

- Memory and Learning, which has been assessed using a single subtest, the Sentence Repetition task, is considerably below what might be expected; however, this is very likely a cultural artifact of the subtest itself, rather than a reflection of children's abilities. Specifically, the Sentence Repetition task requires children to repeat sentences narrated by the assessor. The sentences are presented in North American English; even though this is the same language it can contain vernacular that is unfamiliar to young Caribbean children (Waechter, et al., 2022). To this end, we have developed and are piloting the Grenada Learning and Memory Scale (GLAMS). This test is not yet ready for distribution, as normative data is not yet compiled. However, we do expect that additional information about Grenadian children's memory and learning will be available by

the end of 2022, and that it will show a normal trajectory. Nonetheless, given children's difficulties with the task, educators and other adults may wish to implement interventions to support the tasks of learning: understanding, remembering, and utilizing information.

- We used three separate subtests to assess for Language development: Comprehension of Instructions, Speeded Naming, and Word Generation. As such, we can more confidently assert that many children's language scores were below what might be expected on a normal bell curve as opposed to the Memory and Learning domain. Specifically, 37% fell within the Borderline, Below Expected, or Well Below Expected Levels, and this is a large enough group that interventions should be considered. Proven interventions for language development in 3–5-year-olds include reading to children, narrating events, thinking aloud, and engaging in conversations.

- Sensorimotor and Visuospatial Processing represent motor and nonverbal abilities that children need for construction and for nonverbal tasks such as writing. An expected number of children fell below average ranges, indicating that while interventions are needed for a minority of children, the majority are on target. Interventions known to assist with these skills include building with blocks, manipulating buttons and zippers, sand play, and occupational therapies.

- Cumulatively, social perceptual skills were somewhat lower than might be expected, and lower in 4- and 5-year-olds than in 3-year-olds. Social-emotional understanding, sometimes referred to as emotional intelligence, predicts academic and occupational success, and is the basis of nearly all learning and academic skills. Interventions for social emotional learning, such as those delivered by UNICEF's Safe Schools and Saving Brains Grenada's Conscious Discipline Program, should be implemented.

- Given the cross-sectional cohort-based design of this study, it is not possible to determine whether the same children would fall into the Below Expected Level or Well Below Expected Level in the same domain(s) of development across multiple timepoints. A longitudinal study design is needed to assess development over

time. The brain undergoes rapid development in early childhood, and fluctuations in functional performance are to be expected. In other words, some children might fall in the Below Expected Level in one or more domains at a single time point, but fall into the Borderline, At Expected, or Well Above Expected Level at a subsequent time point. Consistent, low scores across timepoints are more likely to indicate significant delay that requires further investigation and potential intervention. Continued monitoring can help determine whether and what type of remediation is needed, or not.

- Since this study consisted of a single time-point snapshot, we can only be relatively certain that the children scoring in the Well Below Expected Level on any (or multiple) domains should be considered for further follow-up assessment. In this study, 28.7% of 3-year-olds, 23.5% of 4-year-olds, and 23.8% of 5-year-olds fell into this level on any (or multiple) subdomains of neurodevelopmental assessment. Regardless of whether the percentages are correct, we know from these results that, as in other places in the world, there are children whose development is delayed and who need careful, evidence-based expertise in early interventions.

*Limitations*

- The neurodevelopmental assessment tool used in the present study (NEPSY-II) is not validated in the Caribbean region. To our knowledge, no comprehensive neurodevelopmental assessment tool has been validated in the Eastern Caribbean Region. This is a major limitation not only for this study, but any study attempting to assess functioning in a cross-sectional "snapshot" of children. The COVID-19 pandemic impacted the timing of the assessments and the number of assessments completed for this report. Ideally, a cross-sectional design would not collect data over a 27-month period. This was necessary because of the multiple lockdowns that occurred in Grenada starting from March 2020.

- Because we cannot rule out cultural bias of the NEPSY-II nor any other developed-world assessment tools, for future assessments, particularly for those employed for psychoeducational purposes, we would propose adopting a cut-off score

rather than percentiles comparing Caribbean children to those in North America or other regions where tests and testing have been widely adopted.

## CONCLUSION AND FUTURE OPPORTUNITIES

- This study presents the first population-based, quantitative, standardized neurodevelopmental assessment data on early childhood in Grenada. Despite its limitations, the report provides information for government officials, policymakers, educators, parents, and key stakeholders.

- The study provides an impetus for developing and validating neurodevelopmental assessment tools in the Caribbean Region.

- The study provides a template for cross-sectional snapshot assessments of children in other Caribbean nations. Collection of this information in other nations will allow for (1) comparison of early child neurodevelopment across the Region, and (2) collection of more baseline data, which is necessary for eventual validation of the assessment tool (NEPSY-II) in the Caribbean Region.

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