Study Purpose
(What question are the researchers trying to answer?)

One of the common characteristics of children with autism is difficulty with communication. We have known for some time that the brain and the nervous system coordinate all the functions of the body. A large amount of research on the nervous system has shown which parts of the brain are responsible for many functions of the body. The scientists have used many different research methods to study the brain and nervous system.

Researchers have begun to use neuro-imaging techniques (pictures of the brain) to look at the size of brain structures. They look at whether the brain is the same size on the right and left. Researchers are now using a technique called “functional magnetic resonance imaging” or fMRI to take many pictures of the brain. They take the pictures of the brain while people are doing something. This kind of research helps us understand which parts of the brain are being used when people are doing something. fMRI does not use x-rays.

There is a fair amount of recent research evidence looking at ASD and language difficulties. Some of these studies have found that some children with ASD have a little communication or language impairment and some have a lot. Some children may have no functional language (verbal). Some may have difficulty processing what they hear or what they want to say. Some may have normal language. The term “specific language impairment” or SLI, is used to describe the different types of problems a child may have communicating. The term “specific” means a child may have language problems in one or more specific areas. Some children may have problems with vocabulary or finding and saying the right word. Some may have difficulty putting their words in the correct order.
Some may have trouble understanding what is said to them. Each child’s “language profile” describes their difficulties with language and their strengths. “Specific Language Impairment” or SLI and “language profile” are terms used by clinicians and researchers.

A second group of studies has compared the language of children with autism who have SLI to the language of children with SLI who do not have autism. These studies have found, when all things are controlled (such as the age of the child, their gender, and their IQ), the language profile of children with autism and SLI is similar to children with SLI who do not have autism. The results of these studies alone might suggest that SLI in children with ASD may not necessarily be related to the child’s autism. However, we do not have enough research to confirm this.

Promising research studying the parts of the brain which might explain SLI is now being conducted on people with autism. Neuro-imaging studies (images of the brain) of people with autism with SLI have found differences in the structures of their brain when compared to the brains of children with SLI who do not have autism. fMRI studies have also found different parts of the brain are activated (turned-on) for certain language functions in people without ASD who have a SLI. However, early research suggests that this brain activity may be different for people with ASD who have SLI than for people with SLI who do not have autism.

The major parts of the brain which seem to play a part in SLI are the frontal cortex and the cerebellum. The cortex of the brain is where most of the major activities of the body are interpreted or coordinated. See Figure 1 which is a picture of the brain, viewed from the side. As you can see the cortex is a big part of the human brain. It has a right side and a left side. The cortex is the part of the brain where our emotions are regulated. It controls our thinking and problem solving, our vision, hearing, and movement.

Another important part of the brain is the cerebellum. See Figure 1; look at the small structure at the back of the brain (it looks like a chesnut) and Figure 2 (which looks at the brain structures from underneath). Researchers used to think the cerebellum was important because it controlled sensory-motor coordination and balance. We now know that the...
The purpose of this study was to learn more about whether the brain of people with Autism who have speech and language problems is different than people without autism who have speech and language problems. The researchers were trying to answer the following two questions:

1. Is there a difference in the structure and function of parts of the brain in children with speech and language impairment (SLI) compared to children who don’t have SLI?
   a. Is there a difference between children with autism and SLI and children with autism who do not have SLI?
   b. Is there a difference between children with SLI only and normal controls (children with no autism and no SLI)?

2. Is there a difference in the brain between children who have autism and those who don’t?
   a. Is there a difference in the brain of children with autism with SLI and the children with SLI who do not have autism?
   b. Is there a difference between the control children with autism (no SLI) and the normal controls (children with no autism and no SLI)?

**Research Design**
*(What did the Researchers do?)*

The researchers wanted to systematically study specific regions of the cerebellum they believe might be related to SLI in people with ASD. They also wanted to see if the differences they found are also present in children with SLI who do not have autism and in people with ASD who don’t have SLI.

A total of 42 subjects were in this research study. All subjects were boys, ages 6-13 years old. No girls were included. All subjects were right handed. Researchers know that the left side (hemisphere) of the brain is where language is coordinate. Most people who are right handed have what some people call “left-brain dominance.” These are people who are typically very verbal possibly because the language center for the brain is located in the left side of the brain. People who are left-handed are believed to be more creative because creativity is on the right-side of the brain. To have both right and left-handed people in the study might confuse the result.
To answer the study questions, the researchers were careful to collect data on 4 sub-groups of subjects. See Table 1 which summarizes the subjects in each sub-group.

<table>
<thead>
<tr>
<th>Has SLI (speech and language Impairment)</th>
<th>Boys with autism (6-13 years old)</th>
<th>Boys who do not have autism (6-13 years old)</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Has SLI (autism/SLI)</td>
<td>16</td>
<td>9 (no autism/SLI)</td>
<td>25 (have SLI)</td>
</tr>
<tr>
<td>No SLI (speech and language impairment)</td>
<td>6 (autism/no SLI)</td>
<td>11 (no autism/no SLI)</td>
<td>17 (no SLI)</td>
</tr>
<tr>
<td>TOTAL</td>
<td>22 (have autism)</td>
<td>20 (no autism)</td>
<td>42 (total subjects)</td>
</tr>
</tbody>
</table>

To answer the question about whether there are differences in the cerebellum in people with SLI who have ASD and those with SLI who don’t, they had 16 subjects with Autism and SLI and 9 subjects who had SLI but no autism. To see if there is a relationship in what they found and if it is somehow related to autism, researchers also collected data on 6 subjects who had autism but no SLI. Finally, to see if what they found in subjects who have SLI but no autism is related to the SLI, they also collected data on 11 subjects with no SLI and no autism. This design allows the researchers to make many comparisons of what they found to begin to understand how the brain is related to people with ASD who have SLI.

The researchers were careful to measure the criteria for subjects so they could control for factors that might affect their results. They also used data collection techniques which have been used in previous research studies. The methods they used are listed below.

Right handedness was measured using a tool called the Edinburgh Inventory or the Dean Laterality Preference Schedule. ASD was confirmed using three commonly used Autism diagnostic tests. These were the Autism Diagnostic Interview (ADI) and the Autism Diagnostic Observation Schedule (ADOS). The children met the criteria for ASD in the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV). Language skills of each subject were determined using tests from previous research on specific language impairments. In some cases a history of poor performance on language tests and current reports of language-based learning difficulties were used. Because certain diagnoses can cause SLI, children with these diagnoses were not included in the study. The diagnoses not included were neurological (brain) damage, Fragile X, neurofibromatosis, cerebral palsy, tuberous sclerosis, William’s syndrome or Down syndrome.
**MRI Images of the Brain.** MRI procedures can be scary for some children. All subjects in the study were desensitized to the scanner environment and noise of the MRI machine using a “mock” or pretend scanner. Researchers used behavioral shaping techniques to help children get comfortable with the noise and having the dome around their head. Images were taken from the top of the head towards the neck.

**Analyses of the Images**

The images (pictures) of the brain were lined up in the same direction and made larger to see things more clearly. The team then “sliced” the images into very thin slices, using anatomical fissures as landmarks. *Figure 3* on the left shows how they use a computer to separate the brain into parts to compare. Image C shows the fissures used to help separate the parts of the brain.

Researchers used special computer software to measure the parts of the brain that are related to language, cognition, and working memory. The sections in color in *Figure 4* are the areas the researchers were especially interested in measuring.

**Results**

*(What did the Researchers find?)*

There were differences among the sub-groups. First, the subjects with language impairments (with ASD and without) had lower IQ scores than the controls (ASD and without). Second, the ASD controls (no SLI) had significantly lower full scale IQ scores than the normal controls.

When they looked at verbal and performance IQ scores they found an important difference. The subjects with SLI had significantly lower verbal IQ scores than the controls, which you would expect because they have language impairment. But, there was no significant difference in performance IQ scores between the subjects with SLI and the controls. Also, the controls with ASD had lower verbal IQ scores than the normal controls, but there was no significant difference when looking at the performance IQ scores. This means that language ability does affect how children perform on IQ tests. It’s important to looks at both the verbal and non-verbal sub-tests.
Differences in the Brain

The researchers found parts of the cerebellum (white matter) in the brains of children ASD who had SLI were significantly larger than this same part in children who had SLI but did not have autism. They found evidence of what they call “asymmetry” (not equal) in some areas of the brain for the sub-groups. For a part that is in the posterior (back) side of the cerebellum, the right and left side (hemispheres) were not equal in size. It depended on the sub-groups. For the control groups (people with ASD who did not have SLI and normal controls), the right side (hemisphere) was larger than the left side. In the two groups that had language impairments (with ASD and no ASD), they found the opposite. The left side was larger than the right side. See the picture in Figure 5. Usually, when you find a difference like this, it may mean there is something different in the brains of people with language impairments compared to people without language impairments. In another important part of the brain, they found opposite characteristics in the brain. For subjects with SLI (ASD and without), this part of the brain was more on the right side. For the normal language groups (ASD and without), this same area was more on the left side. They also found a difference in the volume (how full) in certain parts of the brain for sub-groups. The volume for subjects with SLI (ASD and without ASD) were significantly smaller than the two control groups (ASD and without ASD).

The researchers learned that both children with SLI with ASD had similar abnormalities of asymmetry (one side bigger than the other) of parts of their brain when compared to children with SLI who did not have ASD. Also, the ASD controls had similar asymmetry with the normal controls. These results made them feel that abnormalities in the brain of children with ASD are more due to language and cognitive deficits than to direct autism effects. However, they said that genetic research should look at how this happens. They agreed that research on genetic susceptibility to autism may have a relationship to other factors. These other factors may lead to these changes in the brain for some people with ASD who have language impairments.

What does this mean for my child and my family?

This type of research is trying to understand the role of the brain in problems that people with ASD have. There are no direct implications for families. The research shows that children with ASD who have language impairments are similar to children who have language impairments but no ASD. We are learning more all the time about how differences we see in children with ASD are because of their autism. We also are finding that children with ASD can have the same language problems as children without ASD. More research is needed in this area which studies the brain. You may consider volunteering for research like this in the future if you are comfortable.
Glossary of Terms

**Posterior** – A medical term used to refer to the back of something. The opposite is “anterior” which means front.

**Lateral** – Refers to the side of something.

**Cerebellum** – The part of the brain in the back of the head next to the brain stem. The cerebellum controls balance for walking and standing and other complex motor functions. New research suggests it is also involved in other more complex brain functions.

**Hemisphere** – Refers to “half” of something. In the brain, there is a right side and left side of the brain (it is called a hemisphere).

**Lobules** – Refers to a small part of an organ.

**Asymmetry** – Means uneven shape.

**Contra-lateral** – Means something that influences the opposite side. Part of brain activity “crosses over” to influence the opposite side of the body. For example, when someone has a stroke on the left side of the brain, it will be the right side of their body that may have weakness or paralysis. People who are more left brain are more inclined to be verbal and right-handed.

**Inferior** – When used in medical terminology, it means below.

**MRI** – Is a device that lets scientists look at the brain in real time and take very detailed pictures. Does not use x-rays. MRIs can be used to examine any part of the body.

**IQ** – Refers to Intelligence Quotient. An estimate of someone’s intellectual ability. There are standard IQ tests that are common and “normed” on large numbers of people. IQ tests can be racially and culturally biased. They can also be biased if someone has a language impairment because many of the questions on an IQ test are using and understanding words.

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