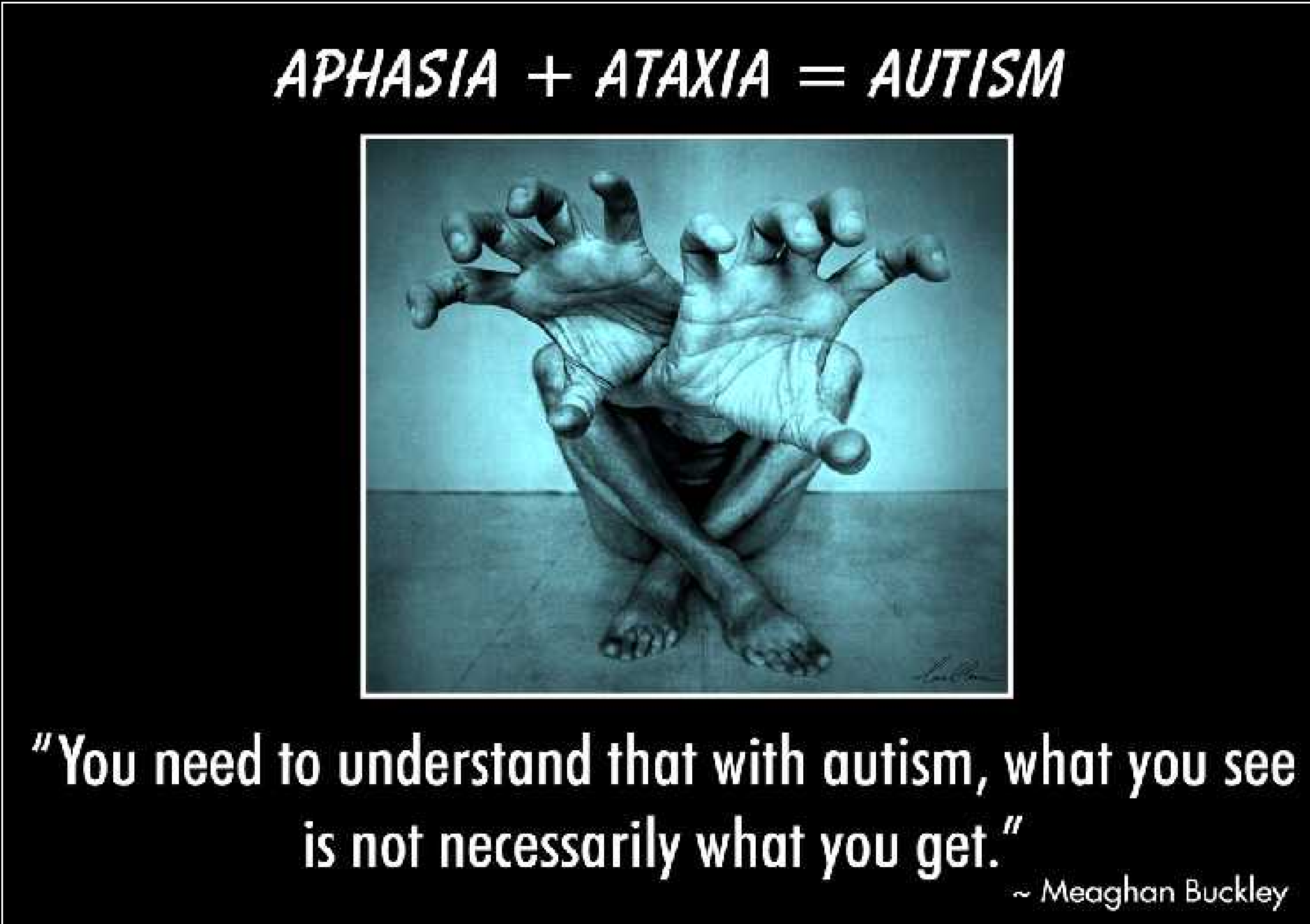
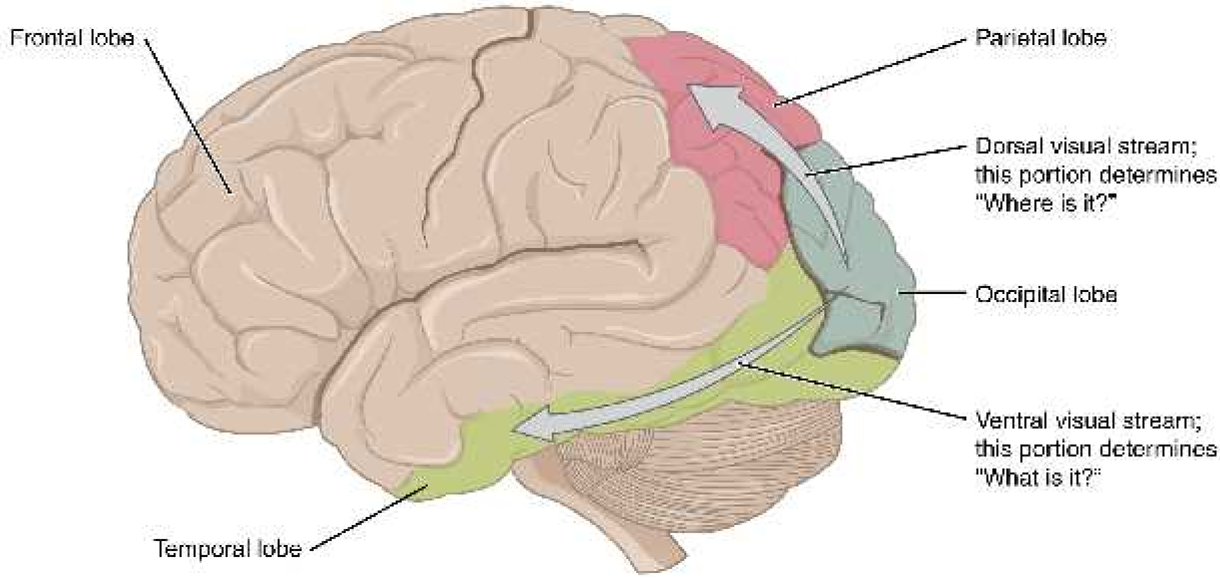



Can you see how the dominoes topple? If one sense is off, it throws off everything in its wake. The failure of even one reflex to integrate fully can cause sensory deprivation that can affect smooth neural network development and processing going forward. With Meaghan, it turned out the most of the reflexes that weren't fully integrated impacted the development of her vision. She can see, but it hurts her eyes to look at anything for any length of time.

This was why it was so surprising to us when she first started doing supported typing. Her eyes were riveted to the keys on the keyboard. For most kids with autism this would not be unusual but for Meaghan it was a miracle. And it is just further evidence of the point we made above about the importance of stimulus salience. As Meaghan says...

> I look when it really matters to me. Typing matters.

It matters so much that she would not give up the battle until she mastered complete independence. And for her, hand-eye coordination was a fierce opponent. Let's see why by following the dorsal visual pathway.




It starts with purely visual functions in the occipital lobe before gradually transferring to spatial awareness at its termination in the parietal lobe, where bodily sensations such as touch are represented. It controls the eyes and arms, especially when visual information is used to guide eye and hand movement. 98

So here is one clue to Meaghan's difficulty with hand eye movement. Her difficulty coordinating her eyes and finger to precisely target the correct key when typing, her hesitation and hovering in doing so, could be the result of some problem in the dorsal end parietal lobe processing of her vision.

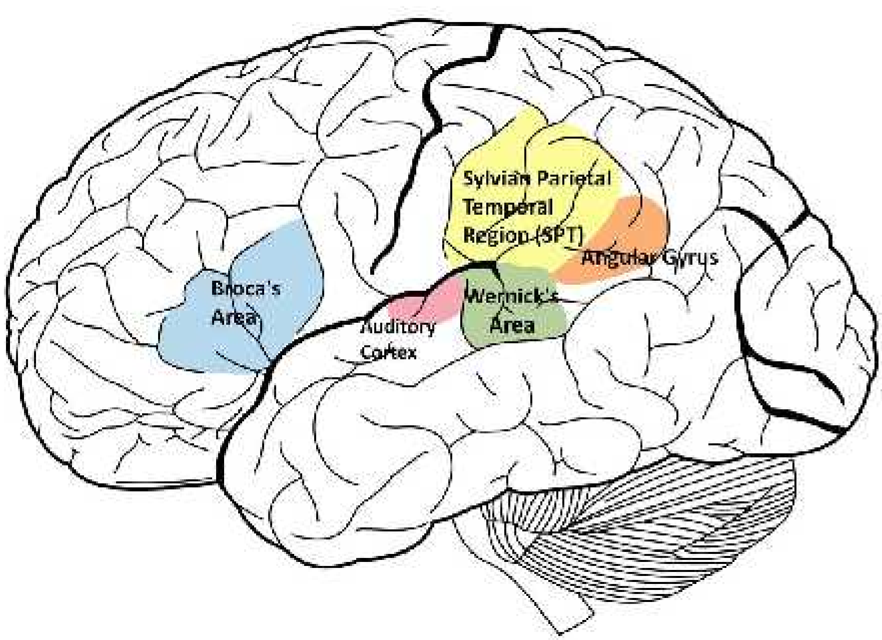
For those who wonder why touch is so important to people with ASD who are learning to type, here is one reason why. Their hand-eye sensory systems depend on it to function.

Imagine being terribly farsighted and attempting to read when you couldn't see the letters on the page. Now imagine having to locate and point to specific words on the page when you had little or no sensation in your arm, hand or finger. Both vision and touch work together in the Parietal lobe to support spatial awareness and fine motor ability.

**The ventral "what" pathway for speech** is equally intriguing as it too plays a role in sensory motor integration and control. Specifically for speech. The function of the auditory ventral pathway is to map auditory sensory representations into articulatory motor representations. 89

The sound pathway starts in the auditory cortex with tones and speech noise and the processing gets more refined the further you go along the pathway until you reach frontal lobe motor regions that are selectively activated by words, transforming them into intelligible speech sounds. 90

But let's go back and focus our attention on the parietal temporal region, midway through the processing loop. It appears that parietal regions are fed a fast, temporally precise, but relatively rough "primal sketch" of auditory information by the auditory cortex. 91 From here sound passes on to the sensorimotor interface, located in the left Sylvian parietal temporal region (SPT).




The SPT (yellow area above) is important for acquiring new vocabulary and perceiving and reproducing sounds. It is responsible for routing auditory code on to the temporal and frontal lobes of the brain so that sound and text can be converted into speech in the motor cortex.

If there is a problem in the wiring of this area or a problem in the wiring going forward on to the articulatory network for motor, language acquisition will be impaired. Speech impairment is called aphasia and there are many types, depending on the region involved.

*Conduction aphasia* is an impairment of the SPT that results in the inability to reproduce or repeat speech, particularly multi-syllabic speech. This makes sense since the SPT is responsible for connecting the motor and auditory systems by making auditory code accessible to the motor cortex. This impairment has no influence on the subject's ability to comprehend spoken language. 92

Testing has shown that most conduction aphasiacs can repeat high-frequency, simple words, it is their ability to repeat low-frequency, complex words that is impaired. It appears that the motor cortex stores high-frequency, simple words (like cup) in order to more quickly and efficiently access them, while low-frequency, complex words (like Sylvian parietal temporal) require more active, hands on regulation by the SPT. 93

> This explains why Meaghan relies on her rote language. It is easy to call up and use. The words she uses are definitely high-frequency, and she does struggle to articulate newer, longer phrases and sentences.

There are other types of aphasia as well, either the result of incomplete wiring or damage to the established language regions of the brain. With conduction aphasia, as we've said, the problem is in the Sylvian fissure or more specifically the arcuate fasciculus, a small region in the fissure vital for both speech and language comprehension.

Adjacent to the arcuate fasciculus are two other important language regions, Broca and Wernicke's areas. If Broca's area is impaired, a person has difficulty moving the tongue or facial muscles to produce the sounds of speech. People with Broca's aphasia have little problem understanding speech, but when they try to speak themselves, they are literally tongue-tied. 94

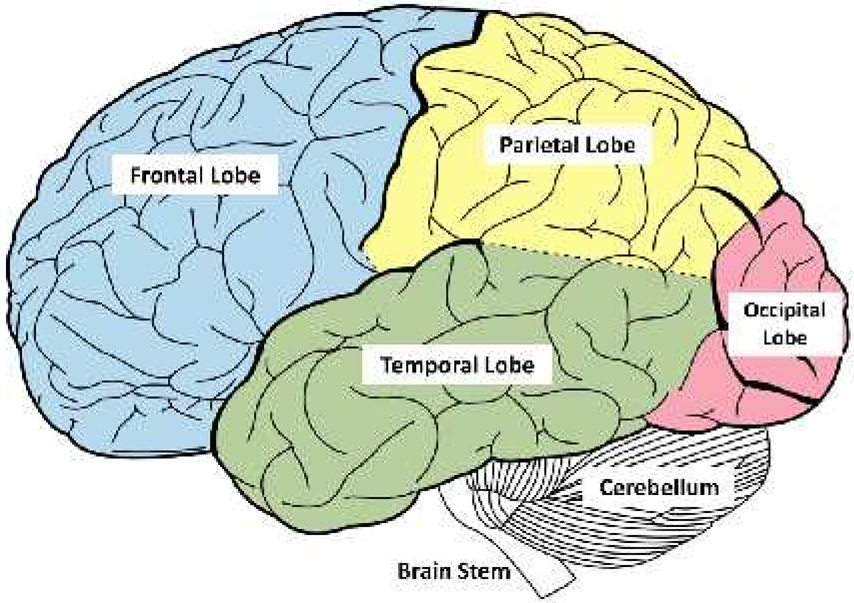
Damage to Wernick's area, on the other hand, has the opposite effect. Someone with this form of aphasia might speak in long, rambling sentences that have no meaning. They combine words that don't necessarily go together, creating "word salads." But while they have no problem speaking, they have difficulty understanding speech, so they are unaware of their mistakes. 95

There is also apraxia, which is a motor disorder that can affect both the motor planning of speech and of tasks or movements. This occurs when there is a problem in the posterior parietal cortex.

Of course, with autism there is more going on than just aphasia or apraxia or any of the other a-named disorders that have to do with the coordination of movement. The bottom line is, Meaghan is absolutely right when she says that...

> People should understand that autism is first and foremost a motor disorder.

There are two very good reasons for this. First, **the dysmetria of the cerebellar purkinje cell programming** at the core of the cerebral processing loop and second, because the **motor processing regions are all in the frontal regions of the brain**, as far as you can get away from the cerebellum. So we are talking about a lot of long neural tracks.




| Frontal Lobe | Temporal Lobe | Parietal Lobe |
|---|---|---|
| • Inability to plan a sequence of complex movements to complete multi-step tasks<br>• Difficulty problem solving<br>• Loss of spontaneity in interacting with others<br>• Loss of flexible thinking<br>• Persistence of a single thought (perseveration)<br>• Mood changes (emotionally labile)<br>• Inability to express language (Broca's Aphasia)<br>• Loss of Inhibition<br><br>• Inability to focus on a task (attention) | • Difficulty recognizing faces<br>• Disturbance with selective attention to what the person sees and hears<br>• Persistent talking (right lobe damage can cause this)<br>• Increased aggressive behavior<br><br>• Difficulty with identification of and verbalization about objects<br>• Difficulty understanding spoken words (Wernick's Aphasia)<br>• Short term memory loss<br>• Interference with long term memory<br>• Inability to categorize objects | • Inability to attend to more than one object at a time<br>• Difficulty drawing objects<br>• Difficulty distinguishing left from right<br>• Lack of awareness of certain body parts and/or surrounding space<br>• Difficulty with hand-eye coordination<br><br>• Inability to name an object (Anomia)<br>• Inability to locate the words to write (Agraphia)<br>• Problems with reading (Alexia)<br>• Inability to focus visual attention<br>• Difficulty doing mathematics |
| **Cerebellum** | **Occipital Lobe** | **Brain Stem** |
| • Dysmetria of thought and behavior<br>• Loss of ability to coordinate fine movements<br>• Difficulty speaking<br>• Inability to make rapid movements<br><br>• Tremors<br>• Dizziness (vertigo)<br>• Slurred speech<br>• Loss of ability to walk<br>• Inability to reach out a grab objects | • Defects in vision (visual field cuts)<br>• Difficulty locating objects in the environment<br><br>• Difficulty identifying colors (Color Agnosia)<br>• Hallucinations<br>• Visual Illusions, or inaccurately seeing objects<br>• Word blindness, or inability to recognize words<br>• Difficulty recognizing drawn objects<br>• Inability to recognize movement of an object (Movement Agnosia)<br>• Difficulty reading and writing | • Difficulty organizing and perceiving the environment<br>• Problems with balance and movement<br><br>• Difficulty swallowing (food and water)<br>• Dizziness and nausea (Vertigo)<br>• Sleeping difficulties (insomnia, sleep apnea) |

The table on the previous page shows specific types of impaired function that can be traced to specific areas of the brain. The red functions are impaired in Meaghan's brain (or were impaired at some point). The blue functions are not. As you can see, the ratio of impaired to not impaired is greatest in the frontal lobe, which is most distant from the cerebellum.

Think of the inner workings of the brain, with its complex network of connections as an information super highway. In order for our brains and bodies to function properly, this highway system must be wide enough for multiple pieces and types of information to travel simultaneously. It must also be smooth, so that data can flow at a high rate of speed. And you don't want interruptions in the flow, so no obstacles, detours or stop lights.

The problem with autism is that, rather than information taking the super highway, some of it seems to detour along back roads. Neural tracts are at times too narrow, too crowded or too bumpy for normal processing to occur. And even when there is smooth going, the highway sometimes leads to a destination that isn't on any neurotypical GPS. Bottom line, the conversion of sensory input to motor output is either short-circuited or atypical.

This is not just true of speech information, although it makes sense since this is the most complex of all motor tasks. Every body movement from a smile to facial expressions, to throwing a ball, to writing, to drawing, to dancing. The list goes on and on. Yes, many kids with autism figure out how to do these things eventually, but it is a tremendous struggle for them.

Not because they don't understand what is expected of them. They do. They understand perfectly well the logistics of showing happiness and playing baseball and writing and dancing. Their minds get it. Their bodies just don't let them do what they want to do because neural messages are not making it all the way from the motor planning areas to the motor execution areas.

> You have to know that my intelligence has opened the door to my communication.

A central problem in motor control, in the representation and perception of the body in space, is how the brain encodes the relative positions of body parts. This sense of limb position depends heavily on vision. 96

> If you doubt this, try closing your eyes and reaching for a glass of wine. You can feel your hand and your arm, so your sense of proprioception is in tact and you probably took in the position of the glass of wine visually before you closed your eyes, but even so, odds are you are going to fumble and spill. Why? Because our brain needs both vision and proprioception to guide your movement.

How much trouble would a person have with motor planning and motor control if both their visual and proprioceptive senses were impaired so that vital cues from the head, eyes, arms, hands and fingers never reached the premotor cortex? How disoriented might a person become if the sensory input she received from her eyes, ears, muscles and joints was unreliable, disconnected or one if source was always conflicting with another.

> I had to learn to use my eyes and control my impulsivity. That was almost impossible to do but my mom worked hard with me and together we worked it out.

This is why individuals with autism often appear awkward and have so much trouble with what to us seem like simple every day tasks. Without the ability to motor plan and coordinate movement, you would be stuck before you got started.

Does this mean that they are stupid or incapable of learning. Absolutely not. It just means that their intelligence lies elsewhere. They are wired differently. We don't presume blind or deaf people to be retarded. They might not be able to use their eyes or ears, but their mind still works. It's the same with people with ASD. They might not be able to feel their bodies, but their mind still works.

This is important. This is where there is so much confusion. Because when it comes to intelligence and memory and understanding, many people with ASD have brains that are far superior to ours. So **some neural impulses, the ones that have less to do with sense and motor and more to do with facts and information, are making it through to their destination unimpeded**.

Why is this?

We will look for the answer in the next chapter.

> You need to understand that with autism what you see is not necessarily what you get. We seem a lot less capable than we are and if you don't know better we both lose out.