SENSORY SURVIVAL OF THE FITTEST

"I don't like doing things that involve my vision."

~ Meaghan Buckley

Even if we assume that the other five senses are not over or under sensitive and it is just the body sense that is "off," not being able to feel your body would definitely mess with your mind. And if this lack of body sensation began when you were an infant or toddler, then your brain would have to find ways to cope with and adapt to it.

Ian Waterman knows first hand how this feels. When he was only 19 years old he developed a flu-like virus that caused him to lose his proprioceptive sense almost overnight. He was later diagnosed with acute sensory neuropathy, a disease so rare that only a dozen or so similar cases are recorded in medical literature. 73

The result of his total loss of proprioception was that, although his muscles worked perfectly, he was unable to control them. "Some months after his virus, Waterman was lying in bed applying all his mental energy to the fight for control of his body. He tensed his stomach muscles, lifted his head and stared down at the limbs that seemed no longer to belong to him. He willed himself to sit up." 74

Later, he realized that it was the visual feedback that allowed his body to unexpectedly obey the mental instruction. "But the euphoria of the moment made me lose concentration and I nearly fell out of bed," he remembers. 75

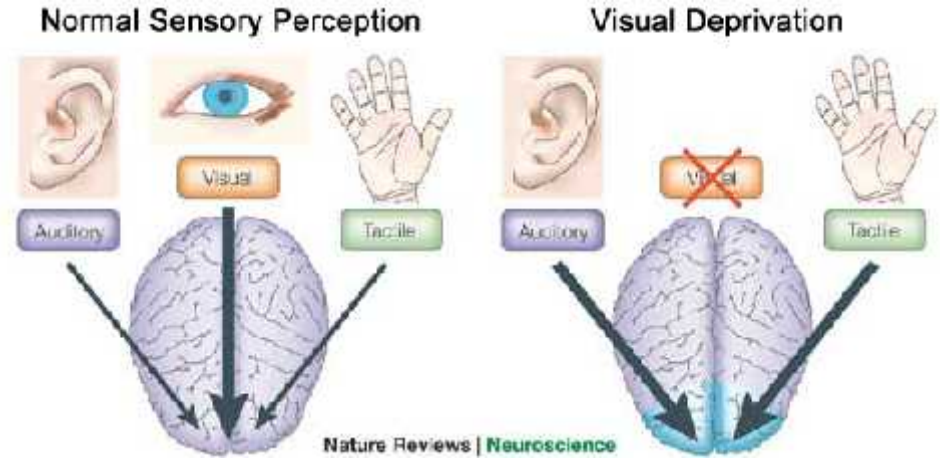
From then on he learned to compensate for his deficit in proprioception with other forms of sensory feedback to help him understand where his limbs are, and thus control them. It requires constant, intense concentration, but now, despite his profound impairments, he can manage fairly normal movements.

Most of the input that he relies on is visual - standing up with his eyes closed is still almost impossible. But he can tune in to the tug of a jacket sleeve to work out the direction his arm is moving or to the cool air on his armpit when he raises his arm in a loose shirt. 76

When I close my eyes, I feel like my body disappears.

What Ian's story tells us is that he compensated for his missing proprioception by using his other senses, primarily his vision. Could this be why so many children with ASD have such highly developed visual senses? And if so, how could this over-dependence on one sense over the others shape the brain?

Cross modal plasticity is the adaptive reorganization (or re-wiring) of neurons originally created for one sensory function to serve another function in the brain. This adaptive network re-wiring generally follows long-term sensory deprivation, such as congenital blindness or deafness, but it can also occur if a person consistently tunes out a sense due to over-stimulation or sensitivity. 77



It is true that if you don't use neural networks, you lose neural networks. But it is also true that the regions of the brain do not disappear. Even though the blind are no longer able to see, the visual cortex is still in active use. It just isn't being used to process visual information. 78

I think you see where I am going with this.

If, like Meaghan, you are only using your eyes when you have to, for momentary glimpses of the world around you, how does this affect the overall development of your brain?

> In Meaghan's case she has spent 30 years listening intently to every conversation that has taken place in her proximity. And all this verbal language has been imprinted in her brain as written language. It makes sense, with her auditory sense being so acute and her visual sense being under used, that some of the neglected visual processing circuits might be reassigned to the novel task of transforming speech into written words.

For kids with autism, if they are consistently tuning out visual or auditory information from a young age, it could be that their somatosensory cortex develops more like that of a blind or deaf person. By this I mean that regions of their brain that are not being used for their original purpose, simply re-wire themselves for another, more useful purpose.

Certainly this could explain some of the higher local connectivity and perhaps differences in that connectivity in the sensory regions that have been found in autistic brains. It could also explain some of the hyper-sensitivities and well as their savant-like capabilities.

But let's dig a bit deeper.

In his book, Reading and The Brain (2009), cognitive neuroscientist Stanislas Dehaene talks about how there are a lot of visual pathways that words can go through that are completely independent of the pathways that those same words go through when you are hearing them. But at some point these two pathways have to meet up. [79]

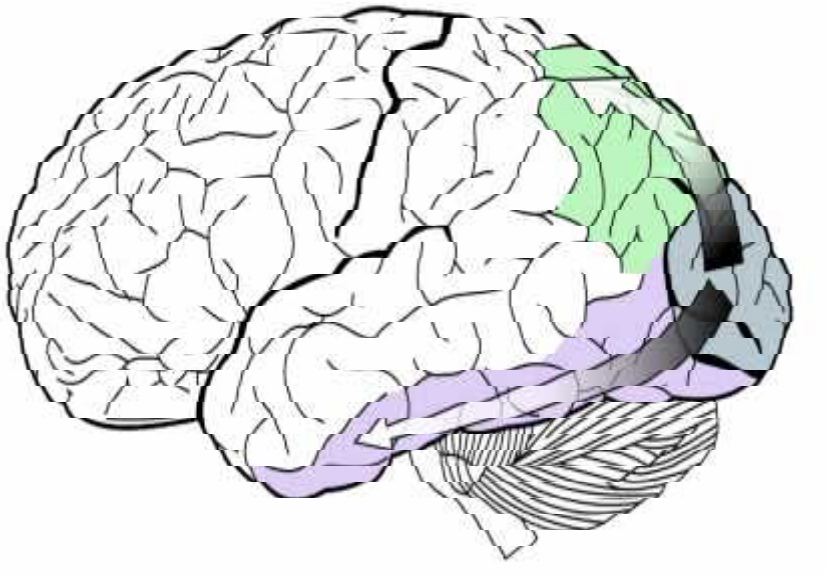
Just what happens when this co-mingling of sight and sound to form language occurs? It is actually quite interesting. Rather than discussing vision and hearing separately, I'm going to discuss the two pathways each sense takes once it enters the brain and the processing implications each pathway has for autism symptomology.

Information from our eyes and ears is routed from the cerebellum through the thalamus to the visual and auditory cortices. From here messages get split into two processing streams: one traveling up the back of the brain (dorsal), the other traveling down the back of the brain (ventral).

Both streams move forward toward the frontal lobe. In general, the farther away a stream gets from its starting point, the more complex the processing carried out by that area. 80

We're going to begin with the **ventral visual pathway. This pathway processes "what" information.** It goes from the primary visual cortex down to the temporal lobe and deals with form and object recognition and representation. It tells you whether you are looking at Donald Trump or an ape. 81

We talked earlier about how spoken language was hard wired into the brain, but reading and writing, being newer on the evolutionary timeline, might hop around in the brain and land anywhere there was space for them. Dehaene and others believe that the space for reading written words is in the left inferior temporal cortex (the area shaded light purple below). 83

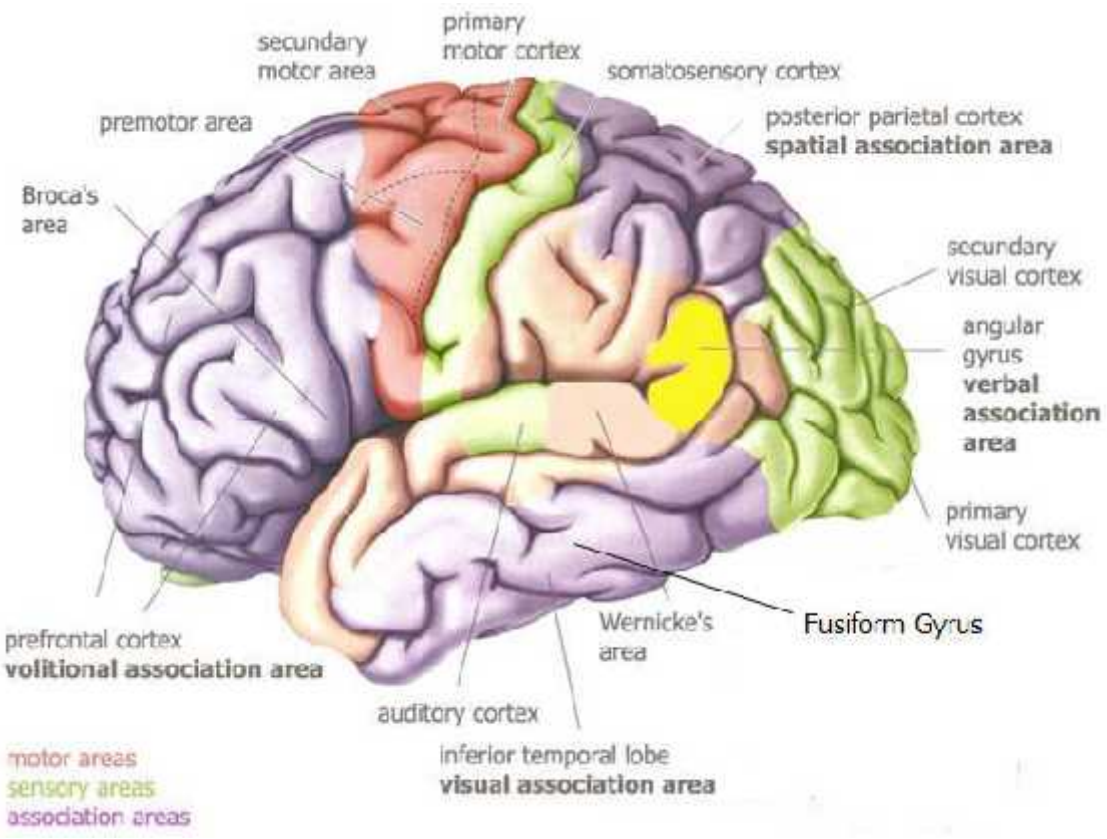


in functional MRI tests on neurotypical brains, this region, which they call the "visual word form area" (VWFA), was consistently activated during reading. They also found that when this region was surgically removed to treat patients with intractable epilepsy, reading abilities were severely impaired. 84

In the same vein, the area right above the inferior temporal gyrus, the fusiform gyrus, is considered by some to be the brain's "letter box." One reason for his is because it is situated in the lateral occipital-temporal area, which makes it a perfect candidate for "neuronal recycling." 85

The process of "neuronal recycling" causes brain circuits that originally evolved for one purpose to become re-trained to do another. So, since the occipital lobe is where line detection takes place and the lateral portion of the temporal

lobe is where object recognition takes place, it makes sense that the next evolutionary step up would be to recognize line drawings, which is essentially what words and letters are. 86



I said that the visual ventral stream passed through the temporal lobe, but specifically, it goes through the inferior temporal cortex, also known as the IT cortex. 87 This is the location of the aforementioned word form (VWFA) and "letter box" areas.

> I don't like doing things that involve my vision.
>
> When I hear words they appear in my brain as spelled out language. My brain is full of piles and piles of words piled up on each other. Written words.
>
> I can recall written words but my auditory memory is limited to rehearsed phrases. The word piles are different. I think in your language but I verbalize in rote responses.

When I type I envision words as I go because they are actually fully evident in my brain.

Because Meaghan has tuned out so much visual input for so long and relied so heavily on her heightened auditory sense, it is possible that when auditory ventral input reaches this region in her brain that should be decoding sounds into spoken words, it is instead decoding them into written language.

Bear in mind, this could also work in reverse. Where Meaghan's brain converts visual and auditory input to written words, Temple Grandin's brain converts written and spoken words into pictures. She thinks in pictures, Meg thinks in written words. Two different variations of the same brain difference.

Here's another interesting thing about the ventral visual stream. All the areas in the stream are influenced by factors that include attention, working memory and stimulus salience,[88] So the "what" a person sees does not necessarily reflect all of the elements in the visual world around them. The significance attached to visual images, in fact, is largely a matter of personal choice.

It has always amazed me that Meaghan who essentially keeps her head down and doesn't look at anything, especially in large, crowded rooms, could somehow spy a lego block in a bag 50 yards away in the back corner of the room. There was no way I could have seen it if I had looked for over an hour. But she could zero in on it in a matter of minutes. And yet, when she was little she could never locate Waldo in the "Where's Waldo?" books. Why? Because he didn't matter to her.

This also might help explain Meaghan's perseverations and reptitions. Her mind gets stuck on certain things, primarily certain objects, but sometimes certain people or places. She keeps repeating their names because she keeps seeing them represented in her mind, and she cannot re-direct her focus to take her mind off of them. I know when I get a song stuck in my head, it's hard to stop singing it. I have to recognize the problem and consciously re-direct my attention. People with autism, on the other hand, take comfort in their repetitions and see no reason to stop them just because they might be driving other people around them crazy.

Damage to the ventral stream (particularly the fusiform gyrus) can cause difficulties with perceptual tasks as well as inability to recognize faces or interpret facial expression. [89]

I think we have a big clue here to why individuals with autism have a hard time with all three of the above.

I will end this section with a conversation Meg and I had about her vision. I have included it because it gives you an idea of just how differently her mind works. I asked her to complete these sentences:

This is how my mind registers what I see...

It uses information from my eyes to tell my brain the world is crazy.

This is what I see when I look around a room...

I see too much for me to take it all in, I usually focus on small details.

This is what I see when I look at a person. For instance, when you look at Uncle Paul, what do you see?

I see his drink. (We're an Irish family!)

What if he's not holding a drink?

I see his skin and hair.

You don't see his features?

No. Because people's features are slippery and they don't get the right trigger to turn on my brain.

This is why it is difficult for me to look in a mirror...

Because I can't be sure I am inside my body. I look pretty okay, but I feel very yucky.

Meg, how do you read?

All at once. I take in everything at a glance.

And you remember it all?

Yes.