Vision versus hearing, which one is dominant?

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Introduction

Our body has a number of senses. The traditionally recognized ones are: sight, hearing, taste, smell and touch. The topic of our thesis is using hearing to compensate for the loss of vision. [1]
While working on our thesis and writing our blog, every now and then the remark 'does this means that vision is more important than sound' came up. [2] Hence, the decision to use this topic as the subject for our paper.

This question has puzzled people across the ages, as is proven by this excerpt from Marcus Tullius Cicero's Tusculanae Disputationes, written around 45 B.C.: *"For, in the first place, what are the pleasures of which we are deprived by that dreadful thing, blindness? For though they allow other pleasures to be confined to the senses, yet the things which are perceived by the sight do not depend wholly on the pleasure the eyes receive; as is the case when we taste, smell, touch, or hear; for, in respect of all these senses, the organs themselves are the seat of pleasure; but it is not so with the eyes. For it is the mind which is entertained by what we see; but the mind may be entertained in many ways, even though we could not see at all. I am speaking of a learned and a wise man, with whom to think is to live. But thinking in the case of a wise man does not altogether require the use of his eyes in his investigations; for if night does not strip him of his happiness, why should blindness, which resembles night, have that effect?"* [3]
He argues for vision being not all-important, and states that in the end, perceiving the world comes down to the brain processing information, more so than the senses gathering it.
This is a familiar idea in modern times, and has an interesting implication: if there is another way to gather enough information, the brain will still be able to form an image of your surroundings. Keeping this in mind, is vision still an essential sense to have? And more specific, is it more important than the other senses in its information-gathering?

In this article, we will mainly focus on the two senses vision and hearing.

Research

How vision and our brain works

Vision is a very complex sense. Vision is more than visualising something that we see with our eyes. It is a complex, learned and developed set of functions that involves a number of skills. It is estimated that eighty to eighty five percent of our perception, learning, cognition and activities are mediated through vision. [4]

As already mentioned in the introduction. It is not our eyes that tell us what we see, but it is our brain that makes up the image in the end. It is not only about what you see with your eyes, but also about how you interpret it. A lot of information reaches the eye, but much is lost by the time it reaches the brain. It is estimated that 90% of the information is

lost. [5] The information gathered by your eyes is directed towards the visual cortex in the brain, which is the normally allocated part for processing visual signals.

Figure 1: an optical illusion, gives you an example of the phenomenon of information loss. You see what you expect to see. Everyone sees the same picture but it can be interpret in different ways. It is even possible to tell your brain what you expect to see.

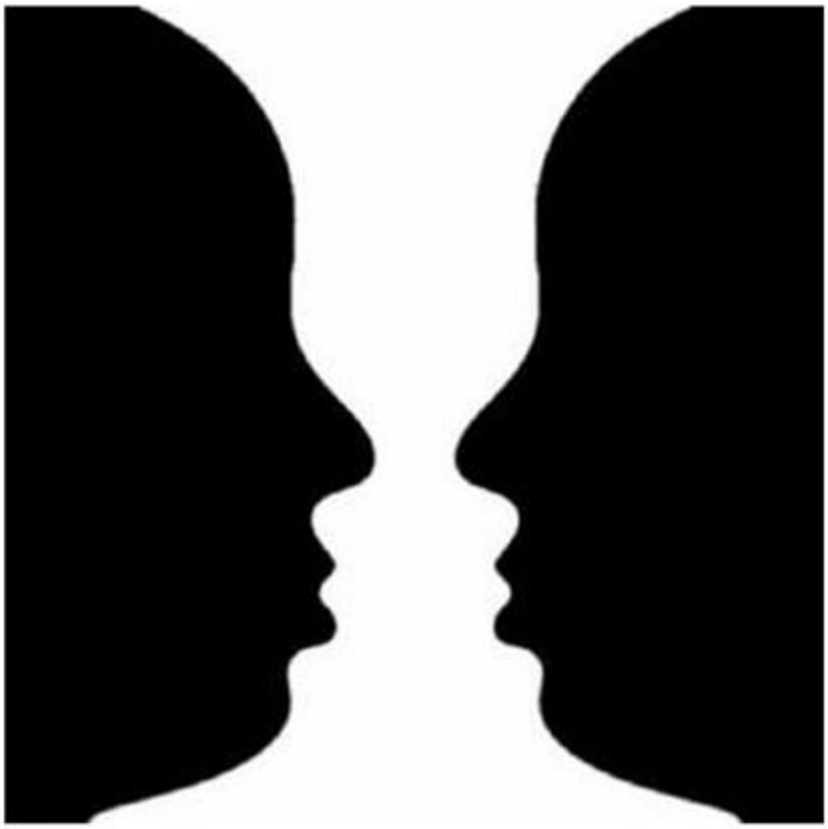

Figure 1: Optical illusion

Figure 2: the different regions of the brain, should give you an adequate idea of the different parts of a brain of a person with five normally functioning senses. As you can see, each sensory input has its own processing region. This implies that the loss of a certain sense would cause a void in the brain. But is this assumption correct to make?

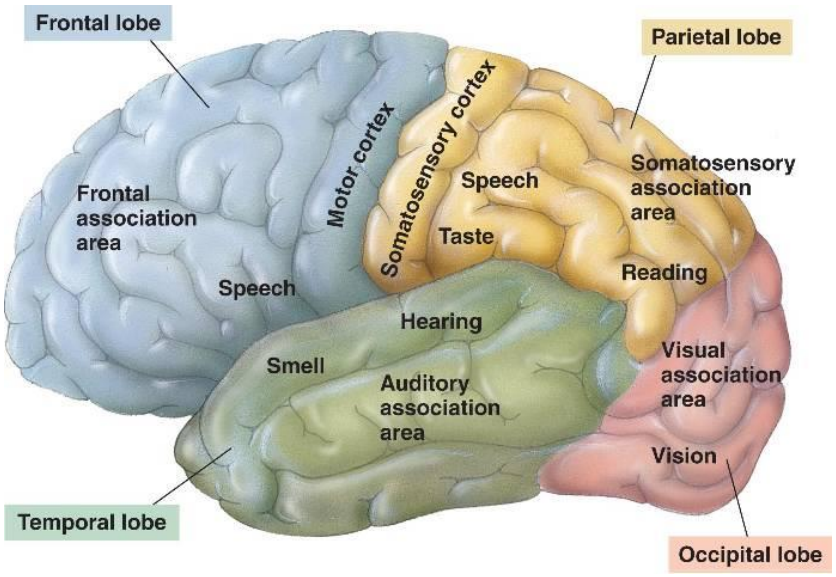

Figure 2: The different regions of the brain

Loss of sight, what else?

When we lose vision, we do not only lose the ability to see with our eyes, but also some other important assets. An example is balance.

Although definitely not only dependent on vision, balance does benefit from it since it an extra feedback system. According to research, balance does not improve over time, contrary to the non-visual senses. [6]

In some researches it is stated that a congenital blind person (person born blind) does not have spatial awareness.[7]

Thus, loss of vision may either enhance or deteriorate auditory localization. Yet, it is not clear to what extent these two opposing mechanisms are at work in the sound localization system of early-blind humans. Earlier studies, which concentrated on sound azimuth localization, demonstrated little difference between blind and sighted subjects. More recent studies, however, have reported that under particular conditions the blind may actually possess superior localization abilities. [8]

Improvement of hearing

It is proven though, that other senses do put in some extra effort when you lose vision. The loss of vision will have as consequence that suddenly you have to depend on other senses and use them in different ways than before. How hard will that transition be? What will happen in your brain?

When we see something, areas of the cerebral cortex that specialize in making sense of visual stimuli light up in the brain. When a person had training in listening to soundscapes (an environment created by sound), it is proven that the same area's in the brain light up. [9] This can be seen in figure 3: active region of blind versus sighted people. Another example is that when a blind person learns to read Braille, their visual cortex lights up [10].

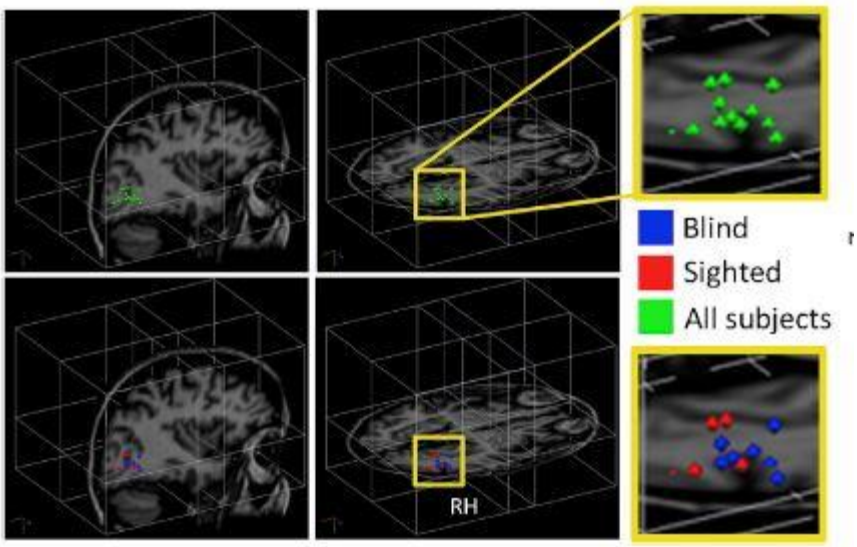

Figure 3: active region of blind versus sighted people

A recent study, done with mice, discovered that when mice are deprived of sight for even a single week, their brain rewires the region to the auditory cortex and their hearing becomes better. This rewiring is reversed when the mice are allowed to see again.
The opposite is true too. When the mice were deprived from hearing, the region connected to the visual cortex is rewired. In further research, they want to see if it is possible to make the change permanent. Although the tests were done on mice, the researchers believe that the human brain works in a similar way. [11]

Other researches state it is not the senses that get better, but it is because vision does not suppress the other senses anymore, the senses are used in a different manner.

An interesting case in this regard is the idea of Sensory Substitution Devices (SSD's). As the name states, they do exactly that: emulate one sense by using another one. Braille reading, for example, would be a sensory substitution of vision by touch. This concept has frequently been applied to replacing vision by another sense, usually hearing or touch, for blind people.
One important observation that is made using devices like this, is that there is activity in the visual cortex of blind people.
For people who have become blind at a later age, this is translated into the idea that with the appropriate amount of training, the input of an SSD for sight will have a similar effect in their brain as visual data did when they could still receive those. [12]
Concretely, when they would recognize audio data representing a ball in a room, they would be able to form a mental picture of a ball in a room, as it would look like when you actually see the ball.
This is in contrast with people who have been blind since birth, who do not perceive sensory substitution this way. Notoriously, it is very difficult for a person that never had vision to grasp the concepts of color, or depth perception. However, there is still activity observed in the visual cortex. [13]
This is one of the reasons why the brain is not considered to be absolutely split up into fixed parts, each responsible for treating some kind of data. Instead, humans are said to have a capability for neural plasticity [14], meaning the brain is capable of certain changes throughout the life of a person. In this case, the brain will attempt to use the otherwise lost resources of the visual cortex for different tasks. Hence it can at least be

concluded that loss of vision does not have an as drastic impact on the total amount of processing power a person possesses as would be expected. On the other hand, the loss of a sense also causes a general decline in the brain mass originally reserved for dealing with this certain type of signals. [15]

Conclusion

Since it is possible for a sense to be replaced in terms of brainpower, the concept of "losing" vision becomes a lot more debatable. You may lose the physical input into your brain, but the brain can treat the data you do get in a more efficient way. At the very least, this proves that vision is replaceable to a certain extent, a quality that can be extended to the other senses. And although it is more of a semantics issue, can one really speak of "dominating" when another sense can take over your spot?

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