

## **The function of the early visual cortex in congenitally blind individuals**

Humans are visual species and large parts of our brains are dedicated to processing information from this sense. What does this brain tissue do in people who have never seen? The advent of brain activity scanning methods, such as functional magnetic resonance imaging, has given scientists an opportunity to investigate this issue. This investigation resulted in a perplexing discovery – occipital brain areas, which usually support visual functions, responds to linguistic, memory and mathematical tasks in blind people.

Does this finding mean that occipital areas assume completely different function in blind people than in sighted people, and truly become engaged in language, memory and math in the blind? Or does the lack of sight simply amplify the typical transfer of information from other brain regions to the visual cortex, which is present also in sighted people (perhaps to support visual or spatial processing)? In this project, we will perform a detailed study of language processing in brains of congenitally blind and sighted people, in order to provide an answer to these questions.

In the first part of the project, congenitally blind and sighted volunteers will participate in a series of brain scanning experiments, in which they will be asked to listen to various auditory and linguistic stimuli, such as sounds, syllables, words differing in meaning, or words differing in a grammatical class. Advanced machine learning techniques will be used to investigate what properties of these stimuli are represented in visual areas in both groups. A particular care will be taken to distinguish between the representation of auditory form of used stimuli and the representation of high-level linguistic properties, such as meaning or grammatical class. In the second part of the project, we will use a brain stimulation technique called “transcranial magnetic stimulation” to temporarily disrupt the activity of the visual cortex in congenitally blind and sighted volunteers. Right after this procedure, the volunteers will be asked to perform various language tasks – for example, to make decisions about meaning or a grammatical class of words - while undergoing a brain scanning session. Studying volunteers’ responses after the visual cortex disruption will allow us to test whether activity of this region is essential for language tasks, in either of the groups. Importantly, administering the language tasks during the brain scanning session will allow us to rigorously control for accidental disruption of activity in other brain areas – by these means, we will obtain a clear picture of visual areas’ relevance for language tasks.

If the visual cortex truly becomes a language region in blind people, then one should expect that (a) this region in the blind represents different, perhaps higher-level language properties than the visual cortex in sighted people; and (b) its activity in the blind becomes critical for language tasks that are not supported by the visual cortex in the sighted. Alternatively, if the lack of sight only amplifies some high-level processes that are present also in the visual cortex of sighted people, then (a) the visual cortex in both groups should represent the same properties of auditory and linguistic stimuli; and (b) the visual cortex in the blind should not be relevant for tasks that are not supported by this region in the sighted. By verifying these predictions, the current project will put the two hypotheses about the fate of the visual cortex in blindness to a critical test.

Tackling this problem gives us a fascinating opportunity to study brain organization in people that experience the world differently than most of us do. On a more general level, investigating the function of the visual cortex in blind individuals is critical for one of the most fundamental debates in psychology and brain sciences – that is, how a brain area assumes its function. A dramatic change in the function of the visual cortex in blind individuals would suggest that the mapping between the brain tissue and specific functions is relatively flexible and determined by our experience. On the other hand, an observation that the visual cortex in the blind keeps performing its typical computations would suggest that this mapping is primarily shaped by our genetics, which, in turn, have been shaped by evolutionary processes, and that our experience only refines this predetermined organization. By testing these alternative possibilities, our project has potential to significantly contribute to this important debate and enrich our understanding of factors determining the mapping between the brain and the mind.