

Cortical circuitry following damage to the primate visual cortex

Abstract for the general public

It is relatively common that people who suffer from a stroke or traumatic brain injury become blind, sometimes in the entire field of vision, other times in specific regions, even if the eyes are not directly damaged. This condition is named cortical blindness. The reason for cortical blindness is that the parts of the brain that generate conscious visual perception (different areas of the cerebral cortex) are no longer receiving the visual information. This information has been carried through cable-like cellular structures that connect the eyes to the cerebral cortex, via intermediate stations deep in the brain (a region called the thalamus). When one particular area of the cortex (called the primary visual area) is damaged, the whole circuit is interrupted - the other areas of the cortex, which give us the sensations of colour, movement and object shape, cannot use the visual information, which results in blindness. This damage is compounded by the loss of specific types of cells, which die in consequence of the damage.

However, we know that when the damage to the primary visual area happens shortly after birth, the results are less severe. Many premature babies suffer damage to V1 during this period, but they grow up to have a conscious vision (although in many cases this vision is not normal). This suggests that the brain can “rewire” its connections, and change its cellular circuits, in some way that allows vision to continue. What exactly happens to allow this is unknown.

In this study, we will compare the brain connections and types of surviving cells following partial removal of the primary visual area in early postnatal life against adulthood. This will provide essential information that will guide the future therapies for cortical blindness by showing how different parts of the visual system react to injury, and what types of remodelling of connections and cellular circuits result in the preservation of conscious vision. We will combine the skills of expert anatomists and brain-informaticians, and use artificial intelligence, to identify the mechanisms that govern the brain rewiring with an unprecedented level of detail. This will provide us with a comprehensive view of how the visual pathway changes after brain damage, and will give us important clues to develop therapies that one day may allow people suffering from stroke or traumatic brain injury to recover visual sensations.