Vision is a very important tool for navigation in general. Due to compensatory mechanisms people who are blind from birth are not handicapped in spatio-cognitive abilities, nor in the formation of novel spatial maps. Despite the growing volume of studies on brain plasticity and navigation in the blind, the compensatory neural substrates or the preservation of this function remain unclear. We have recently demonstrated by using volumetric analysis techniques (Voxel-Based Morphometry) that early blind individuals (EB) show a reduction of the posterior end of the hippocampus on the right side (Chebat et al., 2007a). This cerebral structure is important for the formation of cognitive maps. How do EB form maps of their environment with a significantly reduced posterior right hippocampus? To answer this question we chose to exploit a sensory substitution device that could potentially serve navigation in EB. This tongue display unit (TDU) is capable of transmitting pictorial imagery in the form of electricity on the tongue. Before asking our participants to navigate using the TDU, it was necessary to ascertain that they could really « see » objects in the environment using the TDU. We thus evaluated the « visuo »-tactile acuity of EB compared to sighted blindfolded participants using the TDU (Chebat et al., 2007b).

Participants later learned to negotiate a path through an obstacle course. Their task consisted of pointing to (detection), and avoiding (negotiation) obstacles while advancing through the hallway. We demonstrated that despite a reduced right posterior hippocampus, and an atrophied visual system (for review see: Ptito et al., 2008) EB not only were able to accomplish this task, but had a better performance than the blindfolded sighted controls (Chebat et al., 2011). To determine what the neural correlates of navigation in EB are, we devised an fMRI compatible virtual route task conveyed through the tongue. Participants had to learn to navigate the routes and recognize them. We showed that EB use another cortical network involved in cognitive mapping than the sighted when recognizing routes on the tongue (Chebat & Kupers et al., 2010). We have emphasized neural networks connecting parietal and frontal cortices since they are re-enforced in EB. These results show that the tongue can be used as a portal to the brain by transferring pictorial information from the visual environment of participants, allowing the elaboration of strategies to avoid obstacles and move around in their environment.