Medical Xpress

Modality-independent proto-organization of human multisensory areas in the brain

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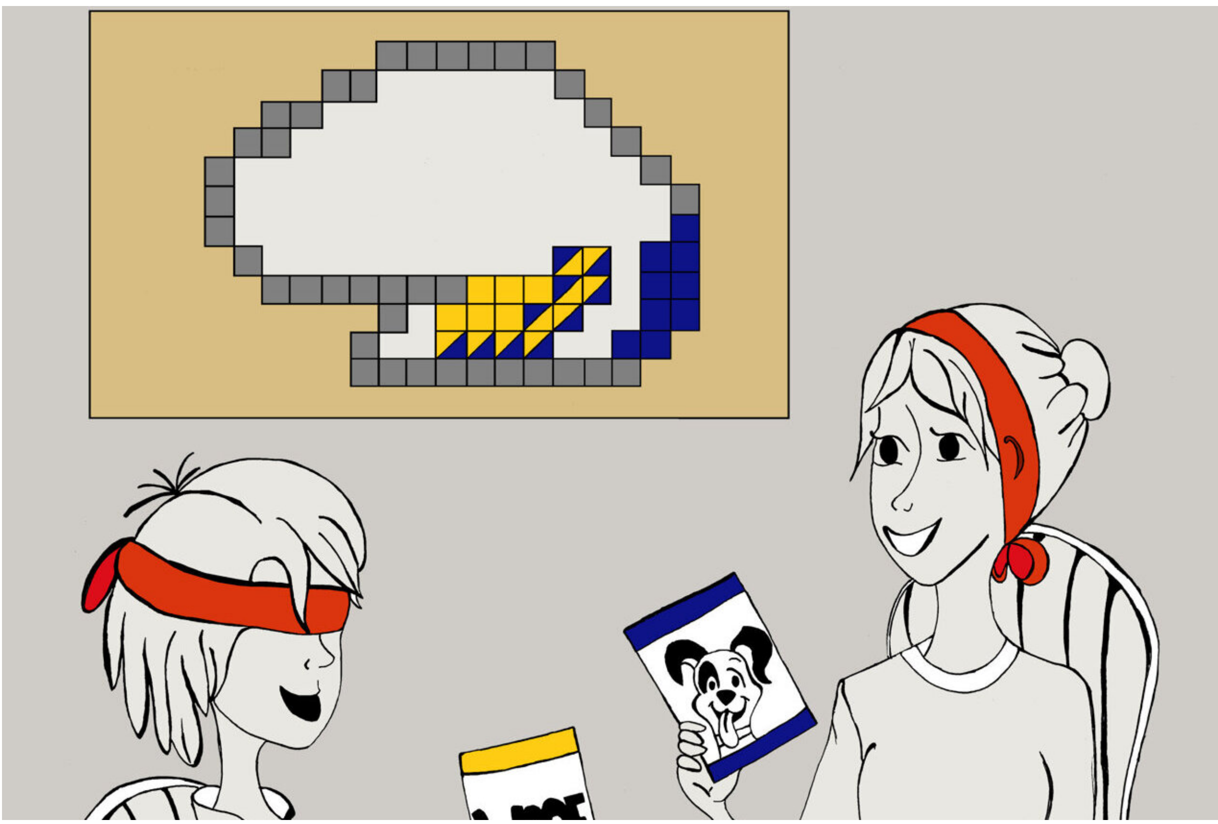

Credit: Francesca Setti, IMT School for Advanced Studies Lucca

To build a representation of the external world, and give it a coherent sense, our brain needs to process and integrate information coming from all our senses, including vision and hearing. But it remains an open debate whether this "multisensory processing" is innate and present from birth in the human brain, or rather develops with experience.

Now, a novel study by an Italian team of neuroscientists from the IMT School for Advanced Studies Lucca and the University of Turin shows that the ability of the brain to represent coherent information across senses primarily relies on an innate functional architecture of specific regions in the brain cortex that work independently from any sensory experience acquired after birth.

The study, published in the current issue of *Nature Human Behaviour*, adds to the old "nature versus nurture" debate, and brings further weight to the evidence that brain architecture can develop independently from sensory experience.

"We hypothesized that some areas of the cortex, known to process more than just one sensory input, may possess a predetermined structure that aids perception of sensory events by matching coherent inputs across sensory modalities," explains Emiliano Ricciardi, professor of psychobiology and psychophysiology at the IMT School, who led the research.

"Since this idea can hardly be tested at birth, we purposely determined the consistent responses across adults deprived since birth of either sight or hearing: any shared brain response across these individuals, whose post-natal experiences inevitably differ, would be indicative of an innate computation."

To conduct the study, the researchers compared the brain activity in three different groups of individuals: people with typical development, congenitally blind and congenitally deaf people. The specific brain response was assessed with Magnetic Resonance Imaging (fMRI) while the subjects were watching or listening to the same edited version of the

Walt Disney's movie "101 Dalmatians." Specifically, blind individuals listened to the auditory version of the movie, while deaf people watched the visual version. The same experimental conditions were adopted with typically developed sighted and hearing individuals.

Brain responses were then compared. "By measuring brain synchronization between individuals who were watching the movie and those who were listening to the narrative, we identified the regions in the brain which coupled information across sensory modalities," explains Francesca Setti, researcher in neuroscience at IMT School and first author of the paper.

"We found that a specific patch of cortex, the superior temporal cortex, endorses a representation of the external world that is shared across modalities and is independent from any visual or acoustic experience since birth, as the same representation is present in blind and deaf participants as well."

In their work, the researchers provided evidence that this area of the brain cortex encodes basic properties of stimuli and couples information from the visual and the acoustic channel. "In simple words, this is the area where the visual image of a 'dog' is coupled with the acoustic signal of the dog barking, making clear to our brain that the two stimuli coming through two different senses refer to the same 'object' in the world," says Setti.

"Overall, these data show that basic visual and auditory features are responsible for the neural synchronization between blind and deaf individuals," adds Ricciardi.

"This research extends results from previous studies by several labs including ours that consistently indicate that most of the large-scale morphological and functional architecture in the human brain can develop and function independently from any sensory experience" says Pietro Pietrini, director of MoMiLab (Molecular Mind Laboratory) at the IMT School and coauthor of the study.

"The wider implications are that we should promote more inclusive educational strategies and social policies for individuals with sensory disabilities, as their brains are the same," concludes Pietrini.

More information: Emiliano Ricciardi, A modality-independent proto-organization of human multisensory areas, *Nature Human Behaviour* (2023). DOI: 10.1038/s41562-022-01507-3. www.nature.com/articles/s41562-022-01507-3

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