Where the brain combines what's heard and felt

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Using functional magnetic resonance imaging, researchers at the Max Planck Institute for Biological Cybernetics in Tübingen, Germany have showed that the integration of auditory and touch information takes place in the 'hearing centre' of the brain – the auditory cortex – and thus at an earlier point than has traditionally been assumed.

Everyday, the brain accesses information from various sense organs simultaneously to create a "picture" of its environment. This important mixture of information from various sense organs is known as "multisensory integration".

Many activities would be difficult to carry out if the brain did not receive information from a number of different sources at the same time. Furthermore, by manipulating multisensory integration, one can create illusions of perception. One well-known example is the 'ventriloquist effect'. If one hears a voice (for example, from a loudspeaker), and then simultaneously sees a face or a mouth moving to speak, then the voice appears to come from the mouth – even when, in the case of ventrioloquist, the mouth belongs to a dummy. Similar effects are known to occur with the other senses: if someone rubs their hands together, they produce a noise that one can use to determine if their hands are dry or raw. If the sound, however, is cleverly manipulated, then subjects make completely different guesses about the condition of their skin.

The auditory cortext in action. The picture was created using functional

magnetic resonance imaging. The colored points indicate regions which react with strong activation to particular impulses. A: tactile stimulation of the hand. B: auditory stimulation. C: simultaneous tactile and auditory stimulation. In C there is more activity than in B, which suggests that the processing of the auditory stimulus is influenced by the tactile stimulation.

One important question in neuro-research is where multisensory integration takes place. Traditionally, it has been assumed that it doesn't take place in the sensory areas, where the information from sense organs comes in, but rather in a downstream, 'higher' area of the brain known as the 'association cortex'. The information from sense organs – in other words, what is taken in – was considered to be first processed in specific sensory areas; for example, the auditory information from the cochlea in the auditory cortex. Only then, it was assumed, it was integrated with similarly prepared information from visual and tactile impressions.

But new findings, including those of the Max Planck researchers, have showed that this description is not exactly correct. Multimodal integration does indeed take place at deeper levels. Using functional magnetic resonance imaging, the scientists from Tübingen measured the activity of brain cells in the auditory cortex of primates. The anatomical partitioning of the primary and secondary auditory cortexes is known in detail and the scientists can take advantage of the high spatial resolution offered by their approach. This is important because the areas under investigation are smaller than two or three millimeters.

The results clearly show that the activity in the auditory cortex by an auditory impulse is strengthened when it is combined with tactile stimulation of a hand. Furthermore, the researchers found areas inside the auditory cortex that react more strongly to simultaneous impulses than to single stimuli – this is a classic criterion for the identification of multimodal integration. The researchers also showed that this integration

takes place in the secondary auditory cortex.

The scientists suspect that one reason that sensory information is combined so early in the brain is that this way false "pictures" can be more easily prevented. Such false pictures match a single sense impression, but are inconsistent across a number of sense impressions. The brain can thus rule them out. However, this speculation, among others, must still be subject to further research.

Source: Max-Planck-Gesellschaft