From sensation to action: How the brain makes decisions

Tübingen Neuroscientists unravel the interplay of brain regions during decision-making

It is often difficult and takes long to make decisions. However, if we think of simple decisions in our everyday life, these are often swiftly and easily made. If you expect a call when your phone rings, you dig your phone out of your pocket and immediately answer it. However, if a call disturbs you while you are engaged in a conversation or listening to a concert, you will usually quickly mute the phone. Such context-dependent decisions are a fundament of intelligent behaviour.

Tübingen Neuroscientist Markus Siegel (Werner Reichardt Centre for Integrative Neuroscience – CIN / MEG Center) together with colleagues from the MIT and from Princeton University (USA) now shows how brain regions interact during flexible decisions, with the results published in “Science”. The new study provides important information on how the healthy brain makes decisions. These insights also help to better understand disorders of cognition and perception in neuropsychiatric diseases such as schizophrenia and, in the long term, may help to develop new treatments.

The brain constantly combines sensory inputs – the phone ringing – with the current behavioral context – expecting a call or listening to a concert – to choose an action. How does this work within the brain? Which brain regions encode the context, and which brain regions make the decision? Does a single region decide, or is it a network of brain regions? How is the decision relayed to the executing stages? The new study by Tübingen Neuroscientists gives important answers to these fundamental questions.

The researchers are able to show that decisions are not made in a single brain region, but that they evolve concurrently in a dense network of frontoparietal regions in the so-called association cortex. From there, neuronal choice signals are relayed not only to motor regions, which control behavioral responses, but also to sensory regions, which first encode the information that the choice is based on. Thus, choice signals are also fed back along the sensorimotor pathway to where sensory information is first processed. Furthermore, Siegel and his colleagues’ findings suggest that the frontoparietal association network is critical for neural processing of the behavioural context. During decision-making, context signals are broadcast from this network to other sensory and motor regions.
Thus, even simple behavioural decisions are based on a complex interplay of widely distributed brain regions. Answering or muting the phone as prompted

by the current situation feels effortless and simple. But in our brain, a widely distributed network of brain regions does the heavy lifting in split seconds: sensory inputs are processed and assessed, inputs are combined with the current context, information is exchanged within the network – everything to finally initiate what feels to us like ‘the natural thing’ to do.

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