Neuroscientists show how decision-making processes are influenced by neurons

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Whether in society or nature, decisions are often the result of complex interactions between many factors. Because of this it is usually difficult to determine how much weight the different factors have in making a final decision. Neuroscientists face a similar problem since decisions made by the brain always involve many neurons. Working in collaboration, the University of Tübingen and the Max Planck Institute for Biological Cybernetics, supported within the framework of the Bernstein Network, researchers lead by CIN professor Matthias Bethge have now shown how the weight of individual neurons in the decision-making process can be reconstructed despite interdependencies between the neurons.

When we see a person on the other side of the street who looks like an old friend, the informational input enters the brain via many sensory neurons. But which of these neurons are crucial in passing on the relevant information to higher brain areas, which will decide who the person is and whether to wave and say 'hello'? A research group lead by Matthias Bethge has now developed an equation that allows them to calculate to what degree a given individual sensory neuron is involved in the decision process.

To approach this question, researchers have so far considered the information about the final decision that an individual sensory neuron carries. Just as an individual is considered suspicious if he or she is found to have insider information about a crime, those sensory neurons whose activity contains information about the eventual decision are presumed to have played a role in reaching the final decision. The problem with this approach is that neurons – much like people – are constantly communicating with each other. A neuron which itself is not involved in the decision may simply have received this information from a neighboring neuron and "joined in" the conversation. Actually, the neighboring cell sends out the crucial signal transmitted to the higher decision areas in the brain.

The new formula that has been developed by scientists addresses this by accounting not just for the information in the activity of any one neuron but also for the communication that takes place between them. This formula will now be used to determine whether only a few neurons that carry a lot of information are involved in the brain's decision process, or whether the information contained in very many neurons gets combined. In particular, it will be possible to address the more fundamental question: In which decisions does the brain use information in an optimal way, and for which decisions is its processing suboptimal?

The National Bernstein Network Computational Neuroscience was initiated by the Ministry for Edu-cation and Research (BMBF) in 2004 in order to establish the research discipline of Computational Neuroscience in Germany. With the support of the BMBF, the network has developed into one of the largest research networks in the field of Computational Neuroscience worldwide. The network's namesake is the German physiologist Julius Bernstein (1835-1917).

The Werner Reichardt Centre for Integrative Neuroscience (CIN) is an interdisciplinary institution at the University of Tübingen funded by the German Excellence Initiative program. Its aim is to deepen our understanding of how the brain generates functions and how brain diseases impair them, guided by the conviction that any progress in understanding can only be achieved through an integrative approach spanning multiple levels of organization.

More information: Haefner R.M., Gerwinn S., Macke J.H., Bethge M. (2013): "Inferring decoding strategies from choice probabilities in the presence of correlated variability". *Nature Neuroscience*, Jan 13, 2013. dx.doi.org/10.1038/nn.3309

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