Circling the Square – Toward a Neuroscience of Neuroscience

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Introduction

Neuroscience can boast many impressive achievements. Activities and phenomena such as visual perception, economic decision making, the driving of motor vehicles, thinking about playing golf or chess, the senses of smell and hearing and the planning of acts both vile and virtuous have all been linked by fairly convincing evidence to neuronal firing and molecular brouhaha inside the brains of mammals choosing to engage in such activities. Even the choosing itself has a neural substrate, as does the amazement at seeing all these impressive achievements. But in spite of such remarkable feats, much of neuroscience is actually not a science at all, but rather a conjectural field full of unfounded hypotheses and circumstantial arguments.

This is due to the fact that much of neuroscience remains on a descriptive and phenomenological level, recording stimuli and the responses to those stimuli, but failing to take into account the mental processes underlying the production of these stimuli and the recording of those responses. An understanding of these neuroscientific processes would be a crucial step toward revealing the mechanisms responsible for the advent of neuroscience, and toward describing the cellular signals involved in creating this fascinating natural process. Ultimately such progress will also help in developing effective medications and therapies for the condition.

I here present the first tentative steps toward such a neuro-neuroscience. As you will see from the FMRI study of reading neuroscientific literature, as well as the accompanying bar graph, much can be said about the substrate of neuroscience, but much more is still waiting to be discovered.

I map out the likely future path of neuro-neuroscience and present a glimpse of neuro^3-science, hinting at a whole family of such sciences, of which neuroscience itself is but the lowest and most humble member.

Understanding the processes involved in understanding the processes involved in seeing something like this may require a whole new set of scientific tools.

Experiment 1
FMRI of Neuroscientific Belief Acquisition Methods

We presented a healthy subject with a sample of randomly picked neuroscientific literature spanning several pages. The subject was asked to visually assess the material and retain as much of its content as possible. The subject was motivated by indicating a high likelihood of exposure to a set of specific questions about said material at a later point in time. At a random time during the reading portion of the experiment, a mechanical stimulus was delivered to various locations on the subject's cranial surface and the resulting reactive resonance phenomenon recorded (see Schreiber, 2003 for details on the method). The mechanical impact point was varied systematically to obtain a resonance distribution image (RDI). The maximal response points of the first three principal components were extracted to find the locations of highest task related sensitivity.

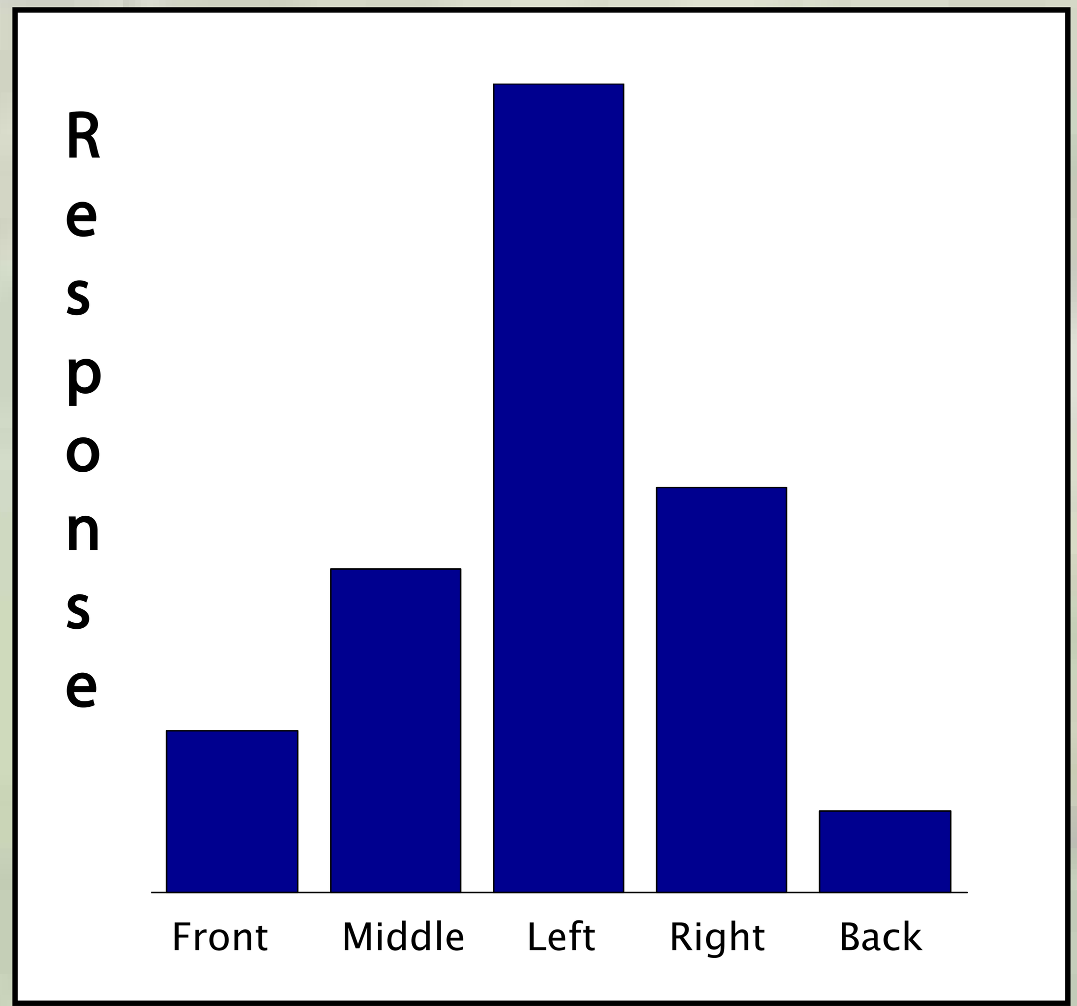
Results

The strongest response by far both in terms of acoustic energy dissipation, motor efficacy and response persistence was elicited in our subject after mechanical stimulation of the left hemicranium. We therefore conclude that acquisition of neuroscientific knowledge is highly lateralized to the left hemisphere. In combination with the well known left brain/right brain dichotomy this suggests that neuroscientific knowledge acquisition in general requires neither emotional nor artistic involvement. However, we cannot exclude an alternate hypothesis based on the temporal order of stimulus application. It is conceivable that the reaction to left hemicranial mechanical stimulation was particularly pronounced because it had been preceded by stimulation of four other cranial regions. We are currently repeating the experiment with a different stimulation order to exclude this possibility. We also would like to encourage the reader to try for themselves by hitting themselves in the head in random locations and recording the results on the feedback sheet to the right.

Experiment 2
Recurrent Network Model of Recurrent Network Modeling

We designed a recurrent neural network with two hidden layers (teacher network). The input to the teacher network was the stimulus/response data obtained in Experiment 1, while its output layer coded the parameters of a second neural network (student network). When the student network's input layer was provided with the literature sample and mechanical head stimulation data, its output layer reproduced the responses of experiment 1.

The teacher network in our setup was able to reliably train a neural network to reproduce the responses of the experimental subject. This shows that the designing and training of neural networks can be done by neural networks. Moreover, by analyzing the internal structure of our teacher network, we can potentially gain insight into the mechanisms involved in the training of the experimental subject for Experiment 1.



Discussion

We have demonstrated experimentally that the acquisition of neuroscientific knowledge can be disrupted by mechanical stimulation of the head, and that this disruption is most pronounced for stimulation of the left hemicranium. This suggests that the ability to read and understand neuroscientific literature is based in the more scientific left brain.

We were also able to build a neural network that was able to build a neural network, thus demonstrating that the ability to make neural networks itself can be explained by a model of interconnected neurons, such as are present in the brain.

Since our teacher model designed a student model that recreated the behavior of the experimental subject in experiment 1, this teacher model captures some of the mechanisms of conducting neuro-neuroscience, and is therefore part of the next level of analysis, which we tentatively call neuro^3-science.

As an exercise to the reader we suggest contemplating the contents of especially this last paragraph again. With sufficient powers of introspection the reader should be able to catch a glimpse of neuro^4-science in his own stream of consciousness. Were someone to sacrifice the reader at that precise moment, slice their brain and stain the slices with appropriate dyes, further levels seem entirely reachable.

Please memorize this poster. There will be a test.

Reference: Schreiber, Kai: The Neural Correlate of Ignorance, SfN 2003.

Download the pdf:
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