KELLY ROE (AUDITING): ASSIGNMENT THREE

One of the core challenges of cognitive neuroscience is translating research findings into information that can improve real-world problems. Choose an applied problem of executive control - e.g., something to do with decision making, impulsiveness, inhibition, etc. - that is manifest in the behavior of neurologically normal individuals. How could neuroscience data be used to help solve that real-world problem? Be specific about what neuroscience can contribute, above and beyond what can be understood from purely behavioral means.

The flip side of the above mentioned problem would be that of justifying that cognitive neuroscience research can provide data (that is over and above the data available from alternative e.g., behavioral paradigms) that can help improve real-world problems for the purposes of obtaining research funding[1]. I am skeptical about the prospects for cognitive neuroscience data assisting in a solution to problems manifest in the behavior of neurologically normal individuals. I am less skeptical about the prospects for cognitive neuroscience data assisting in a solution to problems manifest in the behavior of neurologically abnormal individuals, however. In what follows I'll consider what would have to be the case in order for neuroscientific data to contribute towards economic theories of decision making (with respect to modelling what people actually do). This will involve our considering how to differentiate neuroscientific from behavioral data and interventions, in order for us to see what neuroscience may contribute that is over and above the purely behavioral. I'll end by attempting to justify my claim that it might be more profitable to focus on real world applications with respect to neurologically abnormal individuals[2].

0.1. **What Would Have to be the Case?** One way in which neuroscience is thought to assist is by providing biological constraints for economic models. In order for it to assist several things must be the case, however: Firstly, the biological constraints need to be neuroscientific rather than being available from different methodological approaches. Secondly, the addition of neuroscientific constraints must result in an economic model with greater generalization power / predictive utility than models that are lacking those constraints (such that the neuroscientific constraints are relevant to the modelling of phenomena that economists are interested in predicting).

It is important to note that the movement from objective probability to utility to subjective probability and subjective utility was motivated from the desire to make better sense of the *behavioral* data and neuroscientific data wasn't the driver for this move. Some have argued that one example of neuroscientific data being used to provide evidence that can either support or falsify economic models is in the case of subjective probability, risk, and ambiguity. We have two broadly different economic models: One-variable models treat subjective probability as a single variable. Two-variable models treat subjective probability as being composed of two other variables that are worth distinguishing - risk and ambiguity. It has been found that the pattern of brain activation involved in risk and ambiguity are different. One might then maintain that: '[i]f clear differences were to emerge between the patterns of brain activation evoked by risk and by ambiguity - especially within regions critical for decision making - then one could assume that the process of decision making differs for these conditions'. One might then conclude that the neuroscientific data has provided some evidence in support of the two-variable model over the one-variable model.

While patterns of neural activation are clearly relevant for explaining the brain it is less clear that they are relevant for explaining the behavior that is of interest to economists, however. If two-variable models fare better with their predictions and generalizations then it would seem that economists should adopt a two-variable model given what they are trying to do. If one-variable models fare better with their predictions and generalizations then it would seem that economists should adopt a one-variable model given what they are trying to do. Economic theories seem to be answerable to *behavioral data* and it is hard to see how neurological data is relevant for economic models (though obviously intrinsically interesting in its own right and very useful if we are interested in understanding how brains produce behavior).

A one-variable economist could maintain that the neurological finding shows subjective probabilities to be multiply realized or distributed in the brain. A two-variable economist could maintain that the neurological finding shows subjective probabilities to consist in two different processes. Conversely, if it was

[1]Cognitive neuroscience is not alone - you should try being a philosopher!

[2]While the question stipulated 'neurologically normal' I simply don't see better prospects for real-world applications.

found that there was one neurological process involved in both risk and ambiguity that doesn't support one-variable theories over two-variable theories as two variable theorists could maintain that different tasks can be trained on the same neural network. Since the neurological finding is consistent with both one and two variable models in economics (and since the converse neurological finding would similarly be consistent with both one and two variable models in economics) neurological findings don't seem to support one economic theory over the other[3].

0.2. **Differentiating Kinds of Data and Interventions.** Differentiating the paradigms (e.g., behaviorist, cognitive, cognitive neuroscientific) is problematic as we shall see, but it is important to begin with a fairly intuitive distinction in order to see what neuroscience may be able to contribute that is over and above the alternative paradigms. While behaviorists concerned themselves with S-R relationships (and how reinforcement can alter that relationship) cognitive psychologists concern themselves with developing models that are answerable to a special class of behavioral data - response time, accuracy of responding, double dissociations etc. What cognitive neuroscience contributes over and above these other two theoretical paradigms is data about neurones and populations of neurones. The contribution of neuroscience would seem to be how we can alter stimuli in order to alter neuron activity and how that altered neural activity can in turn alter behavioral output when generalizations from stimuli to neuronal activity and neuronal activity to behavioral output couldn't be predicted from S-R alone.

0.3. **Motivating Looking to Neurological Abnormality.** It thus seems that neuroscientific data is going to be tied to (fairly direct) neuroscientific interventions and manipulations. Using cognitive neuroscientific (rather than S-R) data to alter peoples behavioral output would seem to involve a fairly direct manipulation of neurology. This is because altering the stimulus would count as a *behavioral* rather than *neurological* intervention - but here we are explicitly interested in what cognitive neuroscience can contribute that is *over and above* that which can be done by behavioral methods alone[4]. There are controversies enough about altering the neurology of neurologically *abnormal* subjects[5]. Advocating the alteration of the neurology of neurologically *normal* subjects would seem to be ethically deeply problematic - and yet it is hard to see how cognitive neuroscience could contribute to solving real-world problems neurologically rather than behaviorally or cognitively unless fairly direct neurological intervention was the contribution.

It does seem, however, that that neuroscience research can *inspire* us to attempt what may very broadly be considered behavioral interventions that we would not have been inspired to try without the neurological data. The neurological finding that neurones could regenerate after stroke[6] inspired behaviorists to attempt to rehabilitate stroke victims. *Even though* rehabilitating stroke victims is paradigmatically a behaviorist intervention and attempts are assessable from within the behaviorist paradigm it did, as a matter of fact, take *neurological findings* to result in behaviorists attempting and assessing behavioral interventions. If understanding how neurologically normal individuals work assists us in developing models about what is going wrong in the case of neurological abnormality; and if neurological models of what is going wrong in the case of neurological abnormality either directly or indirectly result in benefits to sufferers; then cognitive neuroscience has a claim to being of more or less direct benefit to sufferers[7]. Whether those interventions are more or less neurological or behavioral history seems to have shown us that it can take neurological finding to inspire new treatments whether those treatments are more appropriately regarded as neurological or behavioral.

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[3]Note: This is not to say that neurology doesn't constrain the behavior of individuals. It is clear that particle physics also constrains the behavior of individuals, however. What is at issue here is whether neurology is more relevant to economic models of what people will do than particle physics.

[4]I suppose there is a problem in that administering some substance or other intervention on the brain might be considered - very broadly speaking - an alteration in stimuli. It does seem that there are many different ways that individuals can be disordered, however, so neurological data is well suited to finding out about what is going on for an individual even if it is less well suited for the population level economic case.

[5]And of course this applies to cognitive and behavioral interventions, too, though perhaps less clearly in marketing and economics.

[6]Or maybe it was that cognitive / behavioral function could be reacquired after stroke - I forget.

[7]More than philosophy, obviously.