Theories Chat Summary

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During the BRAIN Initiative PI Meeting held virtually from June 1 to June 2, 2020 several topics were discussed in a virtual Networking Lounge. The question formulated in this chat was, **What are the roadblocks in generating new theories and integrating competing theories in neuroscience?** There was a consensus that there was a need to address experimental design in animal behavior, theory validation and development, and integration of models across scales. Here we present a summary of the discussion.

There was an overall agreement that classifying and evaluating complex animal behavior should be a focus of future development in theoretical neuroscience. It was pointed out that it is necessary to study animals performing complex tasks since simple tasks often do not yield strong constraints on network dynamics. Hand-in-hand with these experimental tasks, it is important to develop the mathematics of recurrent non-linear systems. A participant pointed out that a fundamental issue is to have non-observer definitions of animal behavior, suggesting that we do not know if what we are evaluating (the observer defined phenotype) is what is most relevant for the animal. Some participants suggested papers that have started to address some of these issues [1, 2].

Another issue arose from a comment that pointed to roadblocks because of the lack of acceptance or skepticism of new theories. This issue is compounded with the model validation problem. It was pointed out that it can take years to develop a new theory, then years to do the hard work to see if it can be cast in a way that generates an experimental prediction that is doable with current technology. It is necessary for the field to have a long-term vision for the development of theories; otherwise, this can stifle novel work. Other participants agreed and added that there is no conceptual roadblock to developing a good theory except time and effort. Since it takes a long time, potentially many years, to develop a theory that can serve as a framework for guiding and interpreting a broad range of experiments. Papers and efforts to tackle these issues were also mentioned in the discussion [3, 4].

Finally, many participants agreed that it is important to build an extensive bibliography about model-based experimental design. A participant suggested software tools in order to provide an environment to put models across different scales [5]. While particular works using non-Markov dynamics were mentioned in this discussion in order to provide a framework of new theories in modeling, others were mentioned to present the mesoscopic dynamical systems [6], rhythmic neurons and spike patterns [7], machine learning methods and dynamical model methods [8]. However, although there are many published works on modeling and validation, one big roadblock to integrating competing theories is model validation testing. If we address this issue as a team then we can avoid ending up with a huge database of databases in model validation.

References

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