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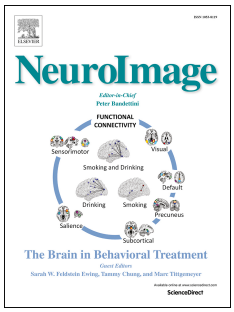

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Warnings and Caveats in Brain Controllability

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Abstract

A recent article by Gu et al. (Nat. Commun. 6, 2015) proposed to characterize brain networks, quantified using anatomical diffusion imaging, in terms of their "controllability", drawing on concepts and methods of control theory. They reported that brain activity is controllable from a single node, and that the topology of brain networks provides an explanation for the types of control roles that different regions play in the brain. In this work, we first briefly review the framework of control theory applied to complex networks. We then show contrasting results on brain controllability through the analysis of five different datasets and numerical simulations. We find that brain networks are not controllable (in a statistical significant way) by one single region. Additionally, we show that random null models, with no biological resemblance to brain network architecture, produce the same type of relationship observed by Gu et al. between the average/modal controllability and weighted degree. Finally, we find that resting state networks defined with fMRI cannot be attributed specific control roles. In summary, our study highlights some warning and caveats in the brain controllability framework.

Keywords: Brain Controllability; Complex Networks; Null Models; Brain Networks; Whole Brain Modelling