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Impaired Cognitive Flexibility & Stimulus Overselectivity in Autism

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Introduction

Various contemporary theories seeking to explain behavior in autism hypothesize that people with autism possess deficits in integrating contextual information in an appropriate manner. Problems integrating information is argued to result in a processing style which highlights the specific pieces of the environment at the cost of more general high-level information. This “piecemeal” style is capable of explaining an impressive variety of both the advantageous and detrimental behavior demonstrated by people with autism. One possible mechanism that could give rise to information integration difficulties would be a tendency to restrict attention to a small number of features, with difficulty in shifting attention to other features. In this work, we explore this possibility using a simple computational model of the role of prefrontal cortex in attention.

Stimulus overselectivity, where a restricted set of components within a compound stimulus tend to dominate behavior, was first documented in the early 1970s in people with autism (Lovaas, Schreibman, Koegel, & Rehm, 1971). This effect has since been demonstrated both within and across different modalities as well as by varying the number of features composing the compound stimulus. The paradigmatic task involves conditioning responses to a stimulus made of multiple, simultaneously presented, components. After the initial association of the compound stimulus with reward/response, each individual component is tested separately, assessing the degree each has acquired control over the subjects behavior. Normally developing individuals respond equally to all components. People with autism, to the contrary, are more likely to respond to a single component, thus demonstrating overselectivity.

Cognitive Flexibility & Overselectivity

Our previous modeling research clearly demonstrates how impaired interactions between the mesolimbic dopamine (DA) system and the prefrontal cortex (PFC) can result in perseverative attention to a single stimulus dimension (Kriete & Noelle, 2006). This mechanism, inspired by the real possibility of DA deficits in autism, proved capable of providing a novel explanation for facets of the development of executive dysfunction in autism. Utilizing an abstraction of this same mechanism, our most recent computational model indicates flexible updating of PFC is needed to capture healthy performance on the stimulus overselectivity task. Importantly, introducing perseverative attention within the PFC control layer of our model (possibly enacted via perturbed DA/PFC interactions) results in a significant increase in stimulus overselectivity,

and provides a mechanism for the appearance of stimulus overselectivity in people with autism.

An intriguing recent study suggests that stimulus overselectivity can be induced in healthy individuals by requiring the concurrent performance of a working memory task (Reed & Gibson, 2005). Working memory tasks are widely believed to enlist the resources of PFC, providing additional support for the conjecture that healthy individuals utilize this area when performing this task.

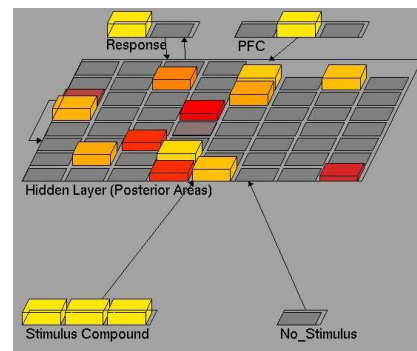


Figure 1: Network diagram of stimulus overselectivity model.

Conclusions

Preliminary modeling efforts qualitatively match human performance and provide evidence that rapid and flexible updating of the PFC is necessary to prevent a restricted cue set from having control over our behavior. Results presented here, coupled with past research, provide further support for a theory of perseverative attention to single features in autism. Indeed, learning over extended developmental timescales with this impairment may lead to behavior which looks like an integration problem on the surface, but, is actually just integrating the wrong information.

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