Bridging the gap between brain and behavior: A dynamic neural field model of executive function captures behavioral and neural development

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Abstract: The Dimensional Change Card Sort task measures the development of executive function. Children must switch from sorting cards based on shape or color to sorting by the other dimension. While 4-year-olds can switch rules, 3-year-olds perseverate. Moriguchi and Hiraki (2009) used Near-Infrared Spectroscopy (NIRS) to measure changes in PFC activation (F7/F8) in this task: 3- and 5-year-olds who switched rules showed stronger prefrontal activation than perseverators. Here, we quantitatively capture these results using a Dynamic Neural Field model. This model was developed to simulate an extensive set of behavioral findings with 3- and 4-year-olds. From the model, we can estimate local field potentials (LFPs) which underlie the BOLD response (Deco et al, 2004). We show that the model yields the same association of PFC activation and correct rule-switching when we convolve the model-based LFP with an impulse response function. Thus, the model simultaneously captures behavioral and neural development.