Number Neurons in the Human and Nonhuman Primate Brain

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Our scientifically and technologically advanced culture owes much to our comprehension of numbers as abstract quantities. Insights from developmental psychology, anthropology, and studies on animal cognition suggest that a fundamental understanding of numbers relies on an evolutionarily and ontogenetically primitive neural system for non-symbolic number representations. To unravel the neural underpinnings of number representations, we conducted research examining single-cell activity in the association cortices of and behaving monkeys and neurosurgical human patients. In our investigations with monkeys, neuronal recordings unveiled neurons tuned to specific numerical values across various non-symbolic number formats. Moreover, we observed that the response properties of numerosity-selective neurons adapt in response to cognitive task demands and goal-directed processing within working memory. Notably, the neuromodulator dopamine was found to influence the fundamental coding characteristics of these neurons through its interaction with the two major receptor families, D1 and D2. In the human brain, distinct neuronal mechanisms were discerned for the rapid assessment of small numbers compared to the approximate estimation of larger numbers. Furthermore, during arithmetic calculations, neurons exhibited an abstract representation of arithmetic rules such as addition and subtraction. this line of research, spanning from the investigation of evolutionary and non-symbolic precursors of number processing in the nonhuman primate brain to the study of the human brain's operations during mental symbolic arithmetic, contributes to our understanding of how neurons and neuron populations encode and process numerical information.