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The neurobiology of individuality

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Individuals often display conspicuously different patterns of behavior, even when they are very closely related genetically. These differences give rise to our sense of individuality, but what is their molecular and neurobiological basis? Individuals that are nominally genetically identical differ at various molecular and neurobiological levels: cell-to-cell variation in somatic genomes, cell-to-cell variation in expression patterns, individual-to-individual variation in neuronal morphology and physiology, and individual-to-individual variation in patterns of brain activity. It is unknown which of these levels is fundamentally causal of behavioral differences. To investigate this problem, we use the fruit fly Drosophila melanogaster, whose genetic toolkit allows the manipulation of each of these mechanistic levels, and whose rapid lifecycle and small size allows for high-throughput automation of behavioral assays. This latter point is crucial; identifying inter-individual behavioral differences requires high sample sizes both within and across individual animals. Automated behavioral characterization is at the heart of our research strategy. In every behavior examined, individual flies have individual behavioral preferences, and we have begun to identify both neural genes and circuits that control the degree of behavioral variability between individuals.