Quantitative properties of a feedback circuit support frequency-dependent pattern separation

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Feedback inhibitory motifs are important for pattern separation in several species. How feedback circuits implement pattern separation of biologically plausible, temporally structured input in mammals is poorly understood, because the spatiotemporal organization of these circuits has not been resolved. We have quantitatively determined key properties of feedback inhibition in the mouse dentate gyrus, a region critically involved in pattern separation. Feedback inhibition is recruited steeply with a low dynamic range (0 to 4% of active granule cells), and with a non-uniform spatial profile. Additionally, net feedback inhibition shows frequency-dependent facilitation, driven by strongly facilitating mossy fiber inputs. Computational analyses show a significant contribution of the feedback circuit to pattern separation of theta modulated inputs, even within individual theta cycles. Pattern separation was selectively boosted at slow-gamma frequencies, in particular for highly similar inputs. This suggests that feedback circuit properties are tuned to optimize pattern separation in specific frequency domains.