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Output specificity of GABAergic interneurons in the rat somatosensory cortex

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The output of GABAergic cells in the cerebral cortex is distributed among pyramidal cells and interneurons and distinct interneuron types evolved to form connections selectively with pyramidal cells and GABAergic cells. We tested 13087 connections between simultaneously whole cell patch clamp recorded neurons recorded during the last 12 years in supragranular layers of the somatosensory cortex of the rat (P18-35). This database yielded 2632 monosynaptic connections involving 4956 neurons. Based on firing and morphological characteristics, we classified the recorded neurons into the following 7 populations: pyramidal cells, neurogliaform cells, Martinotti cells, basket cells, regular spiking cells, axo-axonic cells and irregular spiking cells. Most types of interneurons innervated both pyramidal and GABAergic cells, but axo-axonic cells provided output selectively to pyramidal neurons. In addition, we found that irregular spiking cells innervated GABAergic interneurons exclusively (25 postsynaptic interneurons out of 175 tested), none of the simultaneously recorded pyramidal cells (n=237) received input from irregular spiking cells ($\chi^2 < 0.0001$). We found no sign of morphological heterogeneity among irregular spiking cells which were characterized by a narrow columnar axonal pattern. In conclusion, apart from confirming interneuron types with mixed and pyramidal cell specific output, we identified a homogeneous interneuron population which selectively innervates GABAergic cells in supragranular layers of the somatosensory cortex.