# ROBOTIC CONTROL FROM REALTIME TRANSFORMATION OF MULTI-NEURONAL POPULATION VECTORS

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To investigate the possibility of controlling robotic devices from brain-derived neural population vectors, up to 46 neurons were simultaneously recorded in the forelimb motor cortex, ventrolateral thalamus and/or cerebellum of eight rats trained to obtain water by moving a bar to position a robot arm under a water dropper. These neuronal signals were then electronically weighted and integrated into a realtime brain-derived signal whose timing approximated the onset of bar pressing movement. In recording experiments, control of the robot arm was suddenly switched from the bar press to the brain-derived signal. Four rats successfully used this signal to position the robot arm and obtain water rewards. Over continued training using the brain-derived signal to control the robot arm, the bar-pressing movements steadily diminished or changed their character, indicating a dissociation from the forelimb movements they originally encoded. Various mathematical techniques were investigated to further improve the selectivity and temporal resolution of these brain-derived population vectors. Discriminant analysis was used to derive selective linear weighting functions that successfully encoded limb flexion and extension in multiple dimensions. Moreover, artificial neural networks were used to transform the normally phasic brain-derived signals into control signals that successfully replicated the timing and magnitude of whole limb movements. Thus, brain-derived signals can be used as direct surrogates for operant movements, or with further training, to ultimately replace such movements. Such signals might be therefore be useful for controlling prosthetic devices.