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Organization of the command system in the lamprey brain that initiates locomotor behavior

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In vertebrate animals, the muscle activity pattern for locomotor behavior is produced by central pattern generators (CPGs) in the spinal cord. In the brain, “command” systems, which have several levels, process information and, if appropriate, initiate locomotor behavior. The output neural elements of the command system, which are reticulospinal (RS) neurons, send neural processes to the spinal cord to activate the CPGs and initiate locomotor behavior. The lamprey, a lower vertebrate, has many advantages for studying the organization of command systems. Neurophysiological experiments indicate that several brain areas are part of the command system: rostrolateral rhombencephalon (RLR); ventromedial diencephalons (VMD); dorsolateral mesencephalon (DLM); and RS neurons (Paggett et al. 2004). Other experiments suggest the following organization for the command system: RLR → VMD & DLM → RS neurons à spinal CPGs In the present study, various lesions were made in the brain to interrupt some of the above pathways, and muscle activity (EMGs) was recorded soon after the lesions to test the behavioral capabilities of the animals. Also, for lesions that initially abolished locomotor behavior, EMG recordings were made at various recovery times to determine if axonal regeneration within the brain restored the lesioned pathways in the command system. First, lesions at the mesencephalon-rhombencephalon border, which disrupt the RLR → VMD & DLM pathways, usually abolished locomotor activity that normally would be initiated by stimulation of the head. Two weeks after the above lesion, locomotor activity could once again be initiated by stimulation of the head. Second, lesions in the middle of the mesencephalon or at the diencephalons-mesenencephalon border, both of which disrupt the RLR → VMD but not the RLR → DLM pathways, did not abolish locomotor behavior. Results from the present study support the above model of the locomotor command system in the lamprey brain. Furthermore, the results demonstrate that axons severed by brain lesions could regenerate and restore the function of the command system.