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CHARGES IN INTERNAL VESTIBULE CONTROL INTRINSIC INWARD RECTIFICATION OF KIR1.1 AND KIR2.1 CHANNELS

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Inward rectifier K^+ channels are important in regulating membrane excitability in many cell types. The physiological functions of these channels are related to their unique inward rectification, which has been attributed to voltage-dependent block. Recently, we showed that independent of pore block, inward rectification could also be induced by positively charged and neutral residues at sites 224 in the internal vestibule of tetrameric Kir2.1 channels. The order of extent of inward rectification was E224K mutant > E224G mutant > wild type in the absence of internal blockers. Also, conjugating positively charged methanethiosulfonate to substituted cysteines at sites 224 induced strong inward rectification whereas negatively charged methanethiosulfonate alleviated inward rectification in the E224C mutant. These results suggest that charges at sites 224 may control inward rectification in the Kir2.1 channel. The site equivalent to E224 of the Kir2.1 channel is a glycine residue (G223) in the Kir1.1 channel, which does not show inward rectification in the absence of internal blockers. We hypothesize that other residues near the site 224 may also be involved in the inward rectification of he E224G mutant. We therefore carried out the comparison of surface residues near the site 224 in the internal vestibules and examined the effects of charge reversal, neutralization, or addition at these residues on the inward rectification of Kir1.1 and Kir2.1 channels. We found that each of the H226E, R228E, and R260E mutation could completely correct the inward rectification, increase single-channel conductance, and eliminate open-channel fluctuations of the E224G mutant in the Kir2.1 channel. Also, G223K, N259R, and G223K/N259R mutations of the Kir1.1 channel enhanced the degree of inward rectification. Furthermore, G223E mutation was able to the correct the inward rectification of the N259R mutant. Our study suggests that charged residues in the internal vestibule near sites 224 (Kir2.1) and 223 (Kir1.1) modulate intrinsic inward rectification possibly by contributing to local electrical energy barriers.

S 20-1

BRAIN-COMPUTER INTERFACE STUDY USING HIPPOCMAPAL SINGLE NEURONS

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Recent advances in brain-computer interface (BCI) systems using many single neurons in the motor brain areas have raised the hopes of paralyzed people. However, many types of brain deficits may not allow the actual application of a BCI system based on motor signal decoding. This highlights the need for alternative brain regions for a BCI system applicable to patients with damage to their central motor functions. In this study, we tested the feasibility of encoding neural activities from CA1 hippocampus to control 1-D or 2-D (X- and Y-axes) machine movement through a BCI system. Activities of two groups of single neurons of water-deprived rats were converted in every 200 ms through translation algorithms to three commands for 1-D (Clockwise (CW), Counterclockwise (CCW), STOP and steps) or 2-D (Forward, Backward, Right, Left, STOP and steps) movement control of robots for accessing water. For 1-D movement, a wheel having a water dish was used a robot. For 2-D movement, an X, Y plotter type machine was used as a robot. By using our 1-D BCI system, rats were able to align the portion of the wheel containing water dish in front of the rat to drink water. Rats were also able to control the position of the water dish on the X, Y plotter head to extinguish their thirstiness. The efficiency of robot control was highly dependent on the animal's intention to drink water, which was evidenced by comparing command generation patterns during different intentional states. The efficiency of our BCI system was also elevated with repetition of trials within an hour. These results suggest that CA1 neurons may plastically adapt their activities to control 1D or 2-D robot wheel movement to fulfill rat's intention. Supported by grants from the NBSRC (SNU ERC) and BSRC of the STEPI to H.C.S.