Comparing nervous system responses to neuromodulators in the Kelp crab and the Spider crab

Ahmed Albayaty, 2025

My research this past summer was a continuation of past projects in the Dickinson/Powell Lab aimed at answering the following question: Does an increased modulatory capacity correlate with increased behavioral flexibility? Neuromodulation is the process in which the output of a neuron, or neural circuits, is changed by modulators such as hormones, neurotransmitters, and peptides. Neuromodulation may serve as a substrate for the evolution of behavioral diversity, as the pattern of firing within a neural circuit can change without ever changing the constituents of the circuit itself. Previous research has demonstrated that both the Kelp crab, an herbivore, and the Spider crab, an omnivore, have highly conserved nervous systems yet respond to different numbers of endogenous modulators. Our hypothesis to explain this is that a more flexible nervous system would need more modulators, as responding to more modulators means a direct increase in behavioral responses. Given the two Crabs' differences in diets, this means different digestion patterns. These two crabs also have conserved cardiac nervous systems, so if the hypothesis is supported, we would expect the Kelp Crab's digestive nervous system (stomatogastric nervous system, STNS) to respond to fewer modulators compared to the Spider Crab's system while at the same time expecting the cardiac nervous system to have no significant differences. Preliminary data analysis of past lab work suggests that there is a correlation between increased modulatory capacity and increased behavioral flexibility as the Spider Crab STNS responded to more modulators than the Kelp Crab's, whereas there was little difference in Cardiac nervous system responses.

Table

Modulatory capacity of the Stomatogastric nervous system but NOT the cardiac nervous system correlates with diet

Cardiac Nervous System		
	Kelp	Spider
CabTRP	+	-
CCAP	+	+
Dopamine	+	+
Myosuppressin	+	+
Oxotremorine	+	+
Proctolin	+	-
RPCH	-	-

Stomatogastric Nervous System		
	Kelp	Spider
CabTRP	-	+
CCAP	-	+
Dopamine	+	+
Myosuppressin	??	+
Oxotremorine	+	+
Proctolin	+	+
RPCH	-	+

Table 1. Statistically analyzed Stomatogastric and Cardiac nervous system responses in two different crabs to the application of various endogenous modulators. The **(+)** means that there was a change in the firing pattern of the circuit. The **(-)** means that no difference was found. The **(??)** means that the data has not been statistically analyzed yet.

Faculty Mentor: Daniel Powell
Funded by the Henry L. and Grace Doherty Charitable Foundation Coastal Studies Research Fellowship