Context-specific effects of vasotocin on social approach in the goldfish

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This summer, I studied the effect of the peptide vasotocin (VT) on the social behavior of *Carassius auratus*, the common goldfish. Social behavior is regulated through the social behavior network, a highly conserved group of brain regions that work together to process external stimuli and produce social behavioral responses (O'Connell & Hofmann, 2011). It includes the preoptic area, where VT is produced. VT’s effect on the social behavior network can vary dramatically between species (Thompson & Walton, 2004).

Goldfish live in shoals and are very social fish, which makes them good candidates for studying the effect of VT on social behavior. When a goldfish is isolated, it becomes stressed. When it is shown a visual cue of another fish, it is expected to approach that fish (Thompson & Walton, 2004). Previous work in the Thompson lab has shown that centrally-injected VT has an inhibitory effect on social approach when a male goldfish is shown a visual cue of another male goldfish. This withdrawal from other male fish is understood to be regulated through a neural circuit in the hindbrain. VT can also work through a neural circuit in the forebrain, which is not as well studied. Because the forebrain has many functions related to courtship, one hypothesis is that VT works through the forebrain when the goldfish is in a courtship context, resulting in a different effect on social behavior. Specifically, VT might work through the hindbrain to cause withdrawal when the fish is in a male-male context but work through the forebrain to cause approach when the fish is in a male-female courtship context.

My project this summer was focused on whether VT indeed has context-specific effects on behavior. I began with a short pilot study in which I examined consistency in behavior in general and found that highly social fish tended to stay that way both within and across days. I then performed two behavioral experiments, placing male goldfish in two different social contexts. In Experiment One, I put the fish in a male-male context and hypothesized that VT-injected fish would withdraw more from a stimulus male than saline-injected fish would. While previous work in the Thompson lab had demonstrated this effect with central injections, I hoped to replicate these results using intraperitoneal injections into the body cavity. In Experiment Two, I put the fish in a courtship context by exposing them to female ovulatory pheromones and female stimulus fish. In this case, I hypothesized that VT-injected fish would be more likely to approach the female stimulus fish than saline-injected fish would.

In Experiment One, fish were already in a male-male context having been housed with other males prior to testing; in Experiment Two, I pre-exposed males overnight to a female goldfish ovulatory pheromone prior to testing to create a courtship context. In both experiments, each focal fish was tested twice, once with saline and once with either VT or saline. In Experiment One, I found that VT-injected fish spent significantly less time near the stimulus fish than did saline-injected fish ($F(1,10) = 10.27, p = .009$). In Experiment Two, I found no significant behavioral differences between VT-injected fish and saline-injected fish. Thus, VT indeed has context-specific effects, causing different behaviors in male-male and male-female settings.

I also spent this summer fine-tuning a Western blot protocol that might allow us to explain how VT’s neural circuitry results in these context-specific effects. VT receptors come in two forms: the full-length, fully-functional canonical receptor and the non-functional truncated receptor. One hypothesis is that the social context can actually change the relative density of these two types of receptors in the hindbrain and the forebrain. For example, the male-male context might result in more canonical receptors in the hindbrain, causing VT to work through this pathway and cause withdrawal, while the opposite would be true in the courtship context. The Western blot is a technique that allows the visualization of these receptor types. In addition to fine-tuning the Western blot protocol, I extracted brains from the fish used in my behavioral studies, so that future researchers in the Thompson lab can compare the relative density of VT receptor subtypes in the hindbrain and the forebrain for VT- and saline-injected fish in different social contexts.

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References
