Estrogen receptors and the rapid influence of estradiol in visually guided sexual behavior in male goldfish (*Carassius auratus*)

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The neurological mechanisms that mediate sexual behavior in vertebrates are still very much unknown. Steroid hormones, classically known to act through slow-acting genomic mechanisms, are more recently understood to rapidly mediate cellular and behavioral responses through nongenomic mechanisms as well. In male goldfish, the injection of the steroid hormone estradiol (E₂) rapidly increases social approach responses towards females. However, the receptor by which E₂ mediates this rapid effect is unknown. Estrogen receptors ERα and ERβ, originally thought to be solely intracellular receptors, are now known to be located at the cell membrane as well. Membrane embedded receptors ERα and ERβ as well as G protein-coupled receptor 30 (GPR30), a seven-transmembrane estrogen receptor, could possibly work individually or in collaboration to mediate this rapid behavioral response. One possible technique for understanding the estrogen receptor responsible for these rapid behavioral responses is the use of pharmacological agonists. Agonists are drugs that target specific receptors, activating them in the process. Two agonists, G-1 and diethylstilbestrol (DES), targeting estrogen receptors GPR30 and both ERα and ERβ respectively, were used to determine the estrogen receptor responsible for the rapid influence on the approach response of the male goldfish given only a visual cue of the female stimulus. A two-day protocol was used in which all of the fish were injected with a vehicle solution on the first day and half of the fish were injected with the drug and half were injected with the vehicle again on the second day. The drugs were injected intraperitoneally (into the body cavity). Effect of the drug on the visual approach response was measured using a computer program that tracked the time the fish spent in proximity to the female, in a tank that restricted the female to a specific area (Figure 1a). Time spent in proximity to the female visual stimulus 30-45 minutes after injection revealed no effect of G-1 on the approach response (Figure 1b). Data suggests a trend that DES may increase social approach, though no statistical significance was reached (Figure 1c). Subsequent studies increasing sample size or dosage or controlling for sexually matured goldfish (i.e. milting goldfish) may reveal a significant effect of DES suggesting that E₂ may work through ERα and/or ERβ to rapidly prime, or rather, focus the males attention on the female stimulus. The use of antagonists, drugs that block specific estrogen receptors, may also be utilized.

Figure 1. (a) Illustration of the tank used. Clear dividers separate the male from the female stimulus. Computer program tracks time male spends in area represented by red lines. (b) G-1 data, no significant effect of drug. (c) DES data, while there is a trend, there is no significant effect of drug.

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