The effects of embryonic lead exposure on avoidance learning in zebrafish

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Lead (Pb2+) is a commonly known environmental toxin. Lead poisoning in humans is detrimental, especially if exposure occurs during development when the blood brain barrier and other mechanisms of defense are still being established. In fact, a relationship between early lead exposure and neurobehavioral deficits including slower reaction time, hyperactivity, lower IQ scores, and increased inattentive behavior, has been established in past research. The zebrafish has become a useful vertebrate model for studying the neurobehavioral effects of developmental exposure to environmental toxins because of the ease with which zebrafish can be bred and taken care of, their short generation times, the large numbers of eggs that females can produce, and the transparency of zebrafish embryos.

The current study utilized an active avoidance conditioning paradigm to explore the effects of embryonic Pb2+ exposure on learning and behavior in 12-month-old zebrafish. Adult zebrafish were individually placed in a shuttle-box separated into two identical compartments by a manually raised divider. Each trial began with the onset of light on the side of the shuttle-box where the zebrafish was located. After 12 seconds, a mild, repetitive electrical shock was administered until either the fish swam under the divider or an additional 12 seconds had passed, signaling the end of the trial. On Experimental Day 1, through repeated trials, the zebrafish were trained to associate a light (i.e., conditioned stimulus, CS) with an electrical shock (i.e., unconditioned stimulus, US) and to avoid the shock by swimming from the lighted side of the shuttle-box, under the divider, to the dark side. Testing for avoidance learning occurred on Experimental Day 3.

Adult zebrafish that were exposed to 0.0, 0.1, 1.0, or 10.0 µM Pb2+ as embryos were trained and tested within this paradigm. The results indicated that zebrafish that were not exposed to Pb2+ as embryos learned avoidance responses during training and showed significantly increased avoidance behavior during the testing session. Zebrafish that hatched from embryos exposed to Pb2+ did not show significant changes in avoidance behavior from training to testing, indicating that zebrafish that were developmentally exposed to Pb2+ did not learn avoidance behavior during training. These findings enhance current knowledge of Pb2+ toxicity in developing organisms in that they support the hypothesis that exposure to Pb2+ during development impairs learning and memory.

*This scholar and faculty mentor have requested that only an abstract be published.