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Cadmium and Visual Performance in *Danio rerio*

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Abstract

This study describes the negative effects exerted by cadmium intoxication on behavioral responses to re-illumination with white or colored light in the zebrafish, *Danio rerio.*

Introduction

Cadmium (Cd) is a widespread contaminant of water ecosystems that severely affects the anatomy and physiology of several organs [1-2] including the sense organs [3]. The effects of Cd on behavior have received limited attention to date. For this reason, we treated *Danio rerio* adult fish with a concentration of Cd that is environmentally realistic and determined their visually mediated behavioural responses to re-illumination with white, yellow, green or red light.

Materials and Methods

Adult *D. rerio* individuals were contaminated for 30 days in water containing 0.3 mg/l $CdCl_2$ [4]. The experiments were carried out in a cylindrical tank (fig. 1a) containing a smaller, opaque central cylinder. An aquarium light bulb with mobile red, yellow or green photographic filters was mounted in sector 1 and the tank was equipped with a camera to record fish responses.
After the $CdCl_2$ exposure period each animal was: 1) transferred into the tank for 24 hours to acclimatize; 2) kept in the dark for 1 hour; 3) reilluminated, for one minute each, with white, yellow, green and red light, for a total of 4 minutes.
The behavioral response was assessed by determining: 1) the fishes'activity in the tank, expressed as changes of sector/4 minutes experimentation; 2) the escape response to light, expressed as number of times that the fish occupies the lighted (I), 'dark' (III) or 'dim'(II and IV) sectors.

Results

Activity increases significantly in animals exposed to the yellow light and in Cd-treated animals exposed to the red light (Fig. 1b).

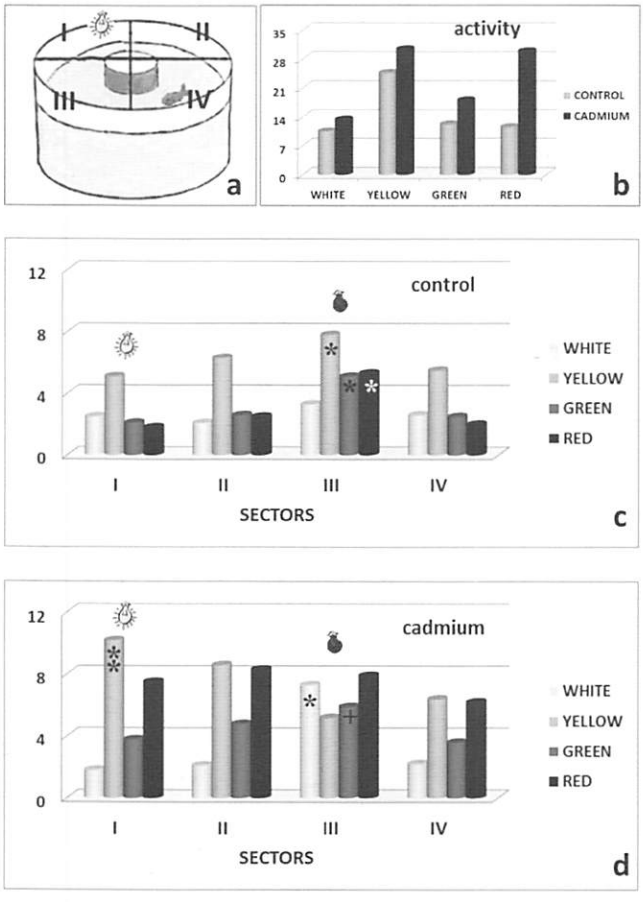

Figure 1. *(a) drawing of the tank used in the experiments. The division into 4 sectors and the light, located on sector I, are visible. (b) fish activities (changes of sector/minute of illumination). The activity rises (*) after exposure to a yellow light and, in Cd-treated animals, also after exposure to a red light. (c) control animals, response to re-illumination with white and colored light. An escape response (*) is observed at all wavelengths. (d) animals treated with 0.3 mg/l $CdCl_2$ (30 days), response to re-illumination with white and colored light. White light induces a significant escape response (*); yellow light attracts the animal (**); green light induces a modest escape response (+); red light does not induce a significant escape response.*

Re-illumination with white or colored light, in control animals (Fig. 1c) induces an evident escape response with animals tending to occupy quadrant III, opposite to the light. In treated animals (Fig. 1d) the response to re-illumination depends on the light wavelength. While white light induces a significant escape response, yellow light attracts the animals to sector I, green light induces a modest escape response and red light induces no response with the animals occupying the four sectors with almost the same frequency.

Discussion and conclusions

This study shows that an environmentally realistic concentration of cadmium alters both light sensitivity and color discrimination in *D. rerio* and we postulate the retinal effects to be on both rods and cones. The ecological implications of these effects may be significant as an impaired visual response would reduce the animals' fitness in both escaping predators and catching prey.

References

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