Behavior Related Neurotoxicity Assessment via Image Analysis on Planarians: Application to Microplastic-Induced Synaptic Impairment

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Microplastics (MPs) have been reported to accumulate in biological tissues and induce neurotoxicity; however, non-invasive quantitative models for evaluating their neurotoxic effects remain limited. This study aimed to develop a low-cost, non-invasive neurotoxicity assessment model using the planarian, Dugesia japonica. Classical conditioning was induced using blue light as the conditioned stimulus (CS) and vibration as the unconditioned stimulus (US). Planarian contraction responses were quantified using OpenCV-based image analysis to measure behavioral learning performance. Compared to the control group, the MP-exposed group showed a reduced conditioned contraction response rate, indicating impaired learning ability at the behavioral level. Furthermore, qRT-PCR analysis revealed significant downregulation of learning and neural function related genes, including Grin1, Tubb3, and Synapsin-1, suggesting synaptic dysfunction associated with microplastic exposure. These results demonstrate the neurotoxicity of microplastics and the fact that planaria can serve as an effective model organism for behavior-based neurotoxicity assessment. This study proposes a behavioral and molecular integrated platform for evaluating environmental neurotoxicity caused by microplastics and suggests its potential application as an environmental neurotoxicity screening system.

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