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The potential relationship between neurobehavioral toxicity and visual dysfunction of BDE-209 on zebrafish larvae: a pilot study

Bin Zhang^{1,2}, Ting Xu^{2,3*}, Daqiang Yin^{2,3*} and Sheng Wei²

Abstract

Background: Although listed in the Stockholm Convention, commercial Decabromodiphenyl ether (c-DecaBDE) is still being produced in many factories and used as a kind of flame retardants primarily in plastic polymers and textiles. Widespread use offered many exposure ways of its major ingredient, BDE-209, to humans and the environment. Most current studies of BDE-209 focused on the health effects and toxicity of thyroid disruption, oxidative stress, neurotoxicity, and reproductive function, but seldom spread light on the relationship between neurobehavioral toxicity and visual dysfunction. Using zebrafish larvae model, we hope to uncover the potential relationship between the neurobehavioral and visual effects after exposure to BDE-209.

Results: BDE-209 exposure could not induce the changes of locomotion and path angle in 5 days post fertilization (dpf) larvae; however, 5 µg/L BDE-209 exposure caused locomotor hyperactivity and more responsive turns at 7 dpf. The social activity of 50 µg/L exposure group was significantly higher than the control group at 6 dpf. Besides, 5 and 50 µg/L exposure caused the upregulation and downregulation of four cone opsin genes, respectively. The expression of rhodopsin gene was not influenced by both concentration exposures.

Conclusion: The neurobehavioral effects induced by 5 µg/L BDE-209 exposure were consistent with the upregulation of four cone opsins in 7 dpf larvae. The low concentration of BDE-209 exposure caused the hyperactivity and more responsive turns of larvae possibly contributing to the disruption on the cone opsin expressions of larvae. Our results would provide the mechanism cue of neurobehavioral toxicity after BDE-209 exposure and call for more attention on the ecotoxicology studies of BDE-209.

Keywords: BDE-209, Neurobehavior, Vision, Zebrafish

Background

Commercial Decabromodiphenyl ether (commercial mixture, c-decaBDE) was listed as a new member of persistent organic pollutants (POPs) under the Stockholm Convention in 2017 amendment because of its

environmental persistence, high potential for bioaccumulation and biomagnification, long-distance transport capacity, and adverse effects; after commercial Pentabromodiphenyl ether (c-PentaBDE) and commercial Octabromodiphenyl ether (c-OctaBDE) have been banned in 2009 amendment (<http://chem.pops.int/TheConvention/ThePOPs>). However, c-decaBDE is still being produced in many factories and used as a kind of flame retardants primarily in plastic polymers and textiles [1]. Widespread use and slow degradation offered many exposure ways of BDE-209, the main constituent in c-decaBDE and

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Neurobehavioral Toxicity Neurobehavioral Toxicity

**United States. Congress. Senate.
Committee on Environment and Public
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Neurobehavioral Toxicity Neurobehavioral Toxicity:

Neurobehavioral Toxicity Bernard Weiss, 1994-06-30 In establishing how certain chemicals can cause behavioural disorders the process of neurotoxicity risk assessment poses significant challenges to every discipline within neuroscience In this volume leaders from industrial academic and government settings share insights on behavioural measurement in neurotoxicity risk assessment and address the critical scientific issues arising from the expanding role of neurobehavioral toxicology in public policy development The authors set out to provide a comprehensive and authoritative review of current methods in the analysis and interpretation of neurobehavioural toxicology Coverage begins with a discussion of criteria for determining neurotoxic potential The next section examines neurobehavioural evaluations in developmental neurotoxicity Subsequent sections focus on activity and observational data and applications of schedule controlled operant behaviour in toxicity testing The contributors address controversies surrounding the suitability and interpretation of procedures designed for neurotoxicological assessments Some case studies are also included

Risk Assessment for Neurobehavioral Toxicity Scientific Group on Methodologies for the Safety Evaluation of Chemicals. Workshop, 1996 *Risk Assessment for Neurobehavioral Toxicity* Bernard Weiss, Jürg Elsner, 1997-07 After three decades of research neurobehavioral toxicity is now acknowledged as a significant outcome of chemical exposure Its health and economic costs may exceed those by cancer by substantial amounts This new perspective has been accompanied by efforts designed to explore the responsible mechanisms to design applicable risk assessment procedures and to determine the consequent policy implications This publication includes 25 papers from international experts and includes human neurobehavioral toxicity animal behavioral methods selected model compounds and risk assessment

Introduction to Neurobehavioral Toxicology Hugh A. Tilson, R.M.A. Jaspers, L.M.W. Kornet, J.M. van Ree, 1998-11-25 Introduction to Neurobehavioral Toxicology Food and Environment examines the effects of chemicals on the central and peripheral nervous system and the subsequent changes in behavior with a focus on the toxicity of food components and behavioral effects of environmental toxicants Topics addressed include acute and chronic effects reversible and *Neurobehavioral Toxicology* Zoltan Annau, 1986 Neuropsychological Toxicology David E. Hartman, 2012-12-06 Greatly revised the Second Edition presents an extended survey of this rapidly growing field The book reviews the effects of industrial and pharmaceutical chemicals on human behavior cognitive function and emotional status Features include two new chapters addressing key forensic issues and recent views on multiple chemical sensitivity sick building syndrome and psychosomatic disorders current data on NIOSH and OSHA exposure levels for industrial toxins and enhanced coverage of testing methods studies of PET SPECT and BEAM imaging applied to neurotoxic exposure

Toxicology in Transition Gisela H. Degen, Jürg P. Seiler, Philip Bentley, 2012-12-06 The volume contains the main papers presented at the 1994 EUROTOX Congress Basel Switzerland August 21-24 1994 Toxicology has become a less descriptive science because more importance has been placed on the mechanisms underlying toxic effects This is reflected in symposia

and workshops devoted to species differences in organ toxicity receptor mediated toxicity and stereochemical effects of xenobiotics Recent progress in the fields of immunotoxicology ecotoxicology and neurotoxicology is highlighted and documented together with the present discussion on harmonized regulatory guidelines **Experimental and Comparative**

Toxicology Charles E. Cornelius, Charles F. Simpson, 2013-10-22 Experimental and Comparative Toxicology Volume 31 aims to explore some of the potentially important and crucial areas in experimental toxicology The book discusses tumor promoters and genotoxic chemicals in short term testing for carcinogenicity as well as the significance of preneoplastic liver lesions in experimental animals The text also describes the factors known to be associated with increased risk of liver neoplasia as a human disease and the extent to which it is known that the same factors have a similar effect in laboratory animals Neurobehavioral toxicology immunotoxicology and the endocrine system as the target in experimental toxicology are also considered The book further tackles the uses of gamma glutamyltransferase in experimental toxicology as well as the predictive value of ocular irritation tests Toxicologists biochemists pathologists and those involved in preventive medicine and community health will find the text invaluable Environmental Health Perspectives ,1993 *Neurotoxicology* Jean Harry G, Hugh A. Tilson, 1999-07-22 This second edition of Neurotoxicology is valuable for scientists in government and industry who are responsible for public health and for the safe and efficient use of chemicals This integrated approach to neurotoxicology will aid in the understanding of the sites and mechanisms of neurotoxicity stimulate the formulation of testable hypotheses about how chemicals affect the nervous system and help improve the risk assessment process This edition focuses primarily on the neurobiological basis underlying neurotoxic sites and modes of action The contents include molecular biological and in vitro approaches potential cellular and molecular sites involving neuron glia interactions axonal transport ion channels metabolic influences on neurotoxicity role of free radical formation in neurotoxicity interaction between chemicals and trophic factors endocrine disruptors apoptosis in neurotoxicity in vivo brain imaging advances in measuring cognitive function advances in developing quantitative models for neurotoxicology risk assessment

Neurotoxins at Home and in the Workplace United States. Congress. House. Committee on Science and Technology. Subcommittee on Investigations and Oversight, 1986 *Agriculture, Rural Development, and Related Agencies Appropriations for 1987: Testimony of members of Congress and other interested individuals and organizations* United States. Congress. House. Committee on Appropriations. Subcommittee on Agriculture, Rural Development, and Related Agencies, 1986 **Agriculture rural development, and related agencies appropriations for 1987** United States. Congress. House. Committee on Appropriations. Subcommittee on Agriculture, Rural Development, and Related Agencies, 1986 **Agriculture Rural Development, and Related Agencies Appropriations for 1987: Testimony of members of Congress and other interested individuals and organizations** United States. Congress. House. Committee on Appropriations. Subcommittee on Agriculture, Rural Development, and Related Agencies, 1986 **Navy Medicine** ,2001

Issues Related to the Use Of, and Exposure To, Various Chemicals United States. Congress. Senate. Committee on Environment and Public Works. Subcommittee on Toxic Substances, Environmental Oversight, Research and Development, 1989

A Comprehensive Guide to Toxicology in Nonclinical Drug Development Ali S. Faqi, 2016-11-03

A Comprehensive Guide to Toxicology in Nonclinical Drug Development Second Edition is a valuable reference designed to provide a complete understanding of all aspects of nonclinical toxicology in the development of small molecules and biologics. This updated edition has been reorganized and expanded to include important topics such as stem cells in nonclinical toxicology, inhalation and dermal toxicology, pitfalls in drug development, biomarkers in toxicology, and more. Thoroughly updated to reflect the latest scientific advances and with increased coverage of international regulatory guidelines, this second edition is an essential and practical resource for all toxicologists involved in nonclinical testing in industry, academic, and regulatory settings. Provides unique content that is not always covered together in one comprehensive resource, including chapters on stem cells, abuse liability, biomarkers, inhalation toxicology, biostatistics, and more. Updated with the latest international guidelines for nonclinical toxicology in both small and large molecules. Incorporates practical examples in order to illustrate day to day activities and the expectations associated with working in nonclinical toxicology.

Behavioral Measures of Neurotoxicity National Research Council, Division of Behavioral and Social Sciences and Education, Commission on Behavioral and Social Sciences and Education, U.S. National Committee for the International Union of Psychological Science, 1990-02-01

Exposure to toxic chemicals in the workplace and at home is increasing every day. Human behavior can be affected by such exposure and can give important clues that a person or population is in danger. If we can understand the mechanisms of these changes, we can develop better ways of testing for toxic chemical exposure and most important, better prevention programs. This volume explores the emerging field of neurobehavioral toxicology and the potential of behavior studies as a noninvasive and economical means for risk assessment and monitoring. Pioneers in this field explore its promise for detecting environmental toxins, protecting us from exposure, and treating those who are exposed.

Annual Report National Institute of Environmental Health Sciences, 1978 *Annual Report*, 1977

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