



# Neuropsychological Consequences of Boxing and Recommendations to Improve Safety: A National Academy of Neuropsychology Education Paper<sup>†</sup>

Robert L. Heilbronner<sup>a,\*</sup>, Shane S. Bush<sup>b</sup>, Lisa D. Ravdin<sup>c</sup>, Jeffrey T. Barth<sup>d</sup>, Grant L. Iverson<sup>e</sup>, Ronald M. Ruff<sup>f</sup>, Mark R. Lovell<sup>g</sup>, William B. Barr<sup>h</sup>, Ruben J. Echemendia<sup>i</sup>, Donna K. Broshek<sup>d</sup>

<sup>a</sup>Chicago Neuropsychology Group and Northwestern University Feinberg School of Medicine, Chicago, IL, USA

<sup>b</sup>Long Island Neuropsychology, P.C., Ronkonkoma, NY

<sup>c</sup>Weill Medical College of Cornell University, New York, NY, USA

<sup>d</sup>University of Virginia School of Medicine, Charlottesville, VA, USA

<sup>e</sup>University of British Columbia, Vancouver, BC, Canada

<sup>f</sup>University of California San Francisco, San Francisco, CA, USA

<sup>g</sup>University of Pittsburgh Medical Center, Pittsburgh, PA, USA

<sup>h</sup>New York University School of Medicine, New York, NY, USA

<sup>i</sup>Psychological and Neurobehavioral Associates, Inc., State College, PA, USA

Accepted 2 January 2009

## Abstract

Boxing has held appeal for many athletes and audiences for centuries, and injuries have been part of boxing since its inception. Although permanent and irreversible neurologic dysfunction does not occur in the majority of participants, an association has been reported between the number of bouts fought and the development of neurologic, psychiatric, or histopathological signs and symptoms of encephalopathy in boxers. The purpose of this paper is to (i) provide clinical neuropsychologists, other health-care professionals, and the general public with information about the potential neuropsychological consequences of boxing, and (ii) provide recommendations to improve safety standards for those who participate in the sport.

**Keywords:** Boxing; Brain damage; Neuropsychological evaluation

## Neurological Injury in Boxing: An Overview

Individual combat competitions have occurred throughout recorded history. Despite, or because of its violent nature, boxing has held appeal for many athletes and audiences for centuries, and it has long been part of the international Olympic Games. Injuries have been part of boxing since its inception. As the sport has evolved, however, rule and equipment changes have improved safety aspects of the boxer. Consistent with most sports, boxing includes both amateur and professional levels. Differences in objectives, rules, and safety equipment convey different risks for amateur and professional boxers (see

<sup>†</sup> The Policy and Planning Committee (Shane S. Bush, Jeffrey T. Barth, Grant L. Iverson, Ronald M. Ruff, Donna K. Broshek) of the National Academy of Neuropsychology (NAN) is charged with writing position and educational papers regarding important issues that affect the profession of Neuropsychology. Possible topics for the papers are suggested by the NAN Board of Directors, members of the NAN Policy and Planning Committee, or individual Academy members. Primary authors are identified and approved by the NAN Policy and Planning Committee. These authors can come from within or outside the Policy and Planning Committee. Selected outside reviewers provide extensive peer review for all papers. All topics and the final paper submissions are reviewed and approved by the NAN Board of Directors. This process of review and approval takes the place of the system of peer review typically conducted by the Editor and Editorial Board of this journal.

\* Corresponding author at: Chicago Neuropsychology Group, 333 North Michigan Avenue, Suite 1801, Chicago, IL 60601, USA. Tel.: +312-345-0933; fax: +312-345-0934.

E-mail address: r-heilbronner@northwestern.edu (R.L. Heilbronner).