ACADEMIC PRESS

Available online at www.sciencedirect.com

SCIENCE DIRECT®

J. Experimental Child Psychology 85 (2003) 178–194

Journal of Experimental Child Psychology

www.elsevier.com/locate/jecp

The developmental course of processing speed in children with and without learning disabilities

Michael David Weiler,* Peter Forbes, Michael Kirkwood, and Deborah Waber

Department of Psychiatry, Harvard Medical School, FB Box 127, Children's Hospital, Boston, MA 02115, USA

Received 31 August 2001; revised 7 January 2003

Abstract

This study contrasted the development of processing speed in children with and without learning disabilities. We examined whether the same global mechanism presumed to be responsible for the normal developmental improvement in processing speed might also be associated with the processing speed deficiencies observed in children with learning impairments. One hundred and twenty-two children with learning disabilities in reading and/or math and 206 non-disabled community controls participated. There were no differences in relation of age to the development of processing speed for children with and without learning disabilities. We interpreted these results as suggesting that the underlying etiologies for the normal developmental change in processing speed and for the relative deficiencies in processing speed seen among children with learning disabilities were different.

Keywords: Processing speed; Development; Learning disability; Information processing

Introduction

In recent years, a number of investigators, Kail and his colleagues in particular, have charted the developmental course of information processing speed (Kail, 1991a; Kail & Bisanz, 1982; Kail & Park, 1992; Kail, Pellegrino, & Carter, 1980;

---

* Corresponding author. Fax: 1-617-566-0785.
E-mail address: Weiler_m@A1.tch.harvard.edu (M.D. Weiler).

0022-0965/03/$ - see front matter © 2003 Published by Elsevier Science (USA).
doi:10.1016/S0022-0965(03)00034-1

Salthouse & Kail, 1983). Many of their findings have been replicated by others (Hale, 1990; Miller & Vernon, 1997). By and large, these researchers have demonstrated that the speed with which an individual processes information changes, in a predictable way, over the course of his or her lifetime. Across a wide variety of tasks, information processing speed increases rapidly through early childhood, increases less rapidly during adolescence, reaches its apex in early adulthood, and gradually declines thereafter (Salthouse & Kail, 1983).

Mathematical formulas have been proposed that model these processing speed changes. Because a child's response time (RT_{child}) is slower than that of the typical young adult (RT_{adult}), the slowing coefficient (m_{age}) in the following formula will be greater than 1. The size of m_{age} is inversely related to the age of the child.

$$RT_{\text{child}} = m_{\text{age}} RT_{\text{adult}}. \tag{1}$$

A number of theories have been advanced to explain the age-related change in processing speed. Some have attributed this change to an increase in experience and/or skill acquisition or to the availability of processing resources. Alternatively (Kail, 1991a) posited the existence of a single, global mechanism.

Kail (1991a) illustrated his global-mechanism hypothesis using a cycle time analogy. As an example, if two computers perform the same task using the same algorithms, any differences in the rate with which they complete the task will depend on differences in their cycle times, or the time needed to execute each instruction (or step) in the algorithm. From this perspective, the developmental trend for decreased RTs would be attributable to a change in something analogous to cycle time, and would affect performances across all tasks sensitive to processing speed.

If, as Kail (1991a) suggested, a single, global mechanism was responsible for the developmental course of processing speed changes, a critical observation would follow: for any particular child (or group of children of any particular age), m_{age} would be constant across different tasks. That is, regardless of the task demands or the number of processing-speed components (PS) required to complete the task (i.e., $RT = PS_1 + PS_2 + PS_3 + \cdots$), m_{age} would affect them all equally (i.e., $RT = m_{\text{age}}PS_1 + m_{\text{age}}PS_2 + m_{\text{age}}PS_3 + \cdots$). As a result, the relation between the response time of an adult to that of, for example, a 10-year-old child, should be the same across the entire range of processing speed tasks (i.e., $RT_{10\,\text{years}} = \text{constant} \times RT_{\text{adult}}$).

In addition to accounting for performances across processing speed tasks, this same global mechanism should also determine the changes in response times over the course of development. Because the developmental course of response time follows a curvilinear trajectory (i.e., steep during early childhood and less so afterwards), an exponential function is required. Kail (1991a, 1991b) proposed that the slowing coefficient (m_{age}) could be modeled by the following:

$$m_{\text{age}} = 1 + b\mathrm{e}^{-c \times \text{age}}. \tag{2}$$

In Eq. (2), e is the base of natural logarithms; c represents the decay parameter which determines the rate at which m_{age} approaches 1, and b is a value that is associated with the intercept of this function (i.e., when $\text{age} = 0$, $\mathrm{e}^{-c \times \text{age}} = 1$, and $b = m_{\text{age}} - 1$).