Journal of Experimental Child Psychology 116 (2013) 914–929

Contents lists available at ScienceDirect

Journal of Experimental Child Psychology

journal homepage: www.elsevier.com/locate/jecp

Development of serial processing in reading and rapid naming

Athanassios Protopapas [a,*], Angeliki Altani [b], George K. Georgiou [c]

[a] Department of Philosophy and History of Science, University of Athens, GR-15771 Zografos, Greece
[b] Graduate Program in Basic and Applied Cognitive Science, University of Athens, GR-15771 Zografos, Greece
[c] Department of Educational Psychology, University of Alberta, Edmonton, Alberta T6G 2G5, Canada

ARTICLE INFO

Article history:
Received 11 April 2013
Revised 6 August 2013
Available online 27 September 2013

Keywords:
RAN
Fluency
Reading
Serial processes
Development
Greek

ABSTRACT

Serial rapid automatized naming (RAN) is more strongly related to reading fluency than naming of isolated words, suggesting that the implementation of serial processing may underlie the RAN–reading relationship. In this study, 107 Greek children from Grade 2 and 107 from Grade 6 were tested with discrete and serial naming of digits, objects, and words in 50-item arrays. The correlation between discrete and serial word reading was very high in Grade 2 but only moderate in Grade 6. In confirmatory factor analysis, a reading–naming latent structure fit the Grade 2 data best; in contrast, a serial–discrete structure fit the Grade 6 data. Thus, the superficial longitudinal stability of RAN–reading correlations belies vastly different patterns of interrelations, indicative of changes in the developing cognitive processes underlying both naming and reading. Word fluency tasks in Grade 2 are apparently accomplished largely as a series of isolated individual word naming trials even though multiple individual letters in each word may be processed in parallel. In contrast, specifically serial procedures are applied in Grade 6, presumably via simultaneous processing of multiple individual words at successive levels. It is proposed that this feat requires endogenous control of cognitive cascades.

Introduction

Rapid automatized naming (RAN) correlates strongly with current and future reading fluency across ages and orthographies (Kirby, Georgiou, Martinussen, & Parrila, 2010). This is presumably

* Corresponding author. Fax: +30 210 727 5530.
E-mail address: aprotopapas@phs.uoa.gr (A. Protopapas).

0022-0965/$ - see front matter © 2013 Elsevier Inc. All rights reserved.
http://dx.doi.org/10.1016/j.jecp.2013.08.004

due to shared component processes underlying both RAN performance and fluent reading. Thus, RAN is conceptualized as a "microcosm or mini-circuit of the later-developing reading circuitry" (Norton & Wolf, 2012, p. 430). The specific processes underlying these concurrent and longitudinal relations remain largely speculative despite decades of research and a variety of theoretical proposals.

Discrete and serial naming

It has long been known that RAN correlates with reading much more strongly when presented in serial form (i.e., all items printed simultaneously on a single sheet) rather than in discrete form (i.e., individual items presented isolated on the screen) (e.g., Bowers & Swanson, 1991; Chiappe, Stringer, Siegel, & Stanovich, 2002; Stanovich, Feeman, & Cunningham, 1983; see also Wolf & Bowers, 1999, for a brief discussion). The serial nature of processing has recently attracted research interest as a potential link between RAN and reading beyond phonological, orthographic, and other general factors (Georgiou, Parrila, Cui, & Papadopoulos, 2013). Studies have examined the RAN–reading relationship both in the general population and in distinguishing between individuals with dyslexia and typically developing readers.

Jones, Branigan, and Kelly (2009) examined discrete and serial letter naming in English-speaking adults with and without dyslexia. They found that the serial format benefited only nondyslexic readers; in contrast, readers with dyslexia named isolated letters faster than letters in a matrix. The impact of serial processing was attributed to the simultaneous activation of multiple visual and phonological representations. Specifically, in the serial task, processing of the current item requires inhibition of a preceding item. Moreover, efficient uptake of information by proficient readers involves parafoveal previewing of the following items (cf. Dare & Shillcock, 2013; Jones, Branigan, Hatzidaki, & Obregón, 2010; Jones, Obregón, Kelly, & Branigan, 2008; Radach, Inhoff, Glover, & Vorstius, 2013; Yan, Pan, Laubrock, Kliegl, & Shu, 2013). In a related study, Zoccolotti and colleagues (in press) compared serial and discrete naming and reading in Italian children with and without dyslexia. They also found that only typically developing readers benefited from the serial format. To interpret this finding, they suggested that cognitive components must be integrated and synchronized with decoding of the visual stimuli while sequentially naming aloud the targets so that each item can be pronounced while the next one is viewed.

In the general English-speaking population, Logan, Schatschneider, and Wagner (2011) examined the concurrent correlations among reading and naming measures in kindergarten, Grade 1, and Grade 2. They focused on the distinction between discrete and serial naming in accounting for variance in reading accuracy. They found that serial naming predicted reading outcomes after controlling for discrete naming and other measures of phonological processing. In contrast, discrete naming did not contribute to reading accuracy variance after controlling for serial naming but instead acted as a suppressor variable, enhancing the contribution of serial naming. Logan and colleagues rejected the "lexical access" hypothesis, according to which the RAN–reading relationship is due to the need for rapid access of phonological codes. Instead, they suggested that aspects of serial processing such as eye movements and parafoveal processing may form the underlying link between RAN and reading.

De Jong (2011) examined developmental differences in the RAN–reading relationship. He identified two classes of Dutch children in Grades 1, 2, and 4 with different patterns of intercorrelations. In the group including most younger children, serial naming tasks predicted both serial and discrete word reading better than discrete naming tasks. In contrast, in the group including most older children, serial naming tasks predicted serial reading and discrete naming tasks predicted discrete reading better than vice versa. De Jong interpreted this pattern as reflecting a change in the way individual words are processed: Whereas during earlier stages of reading development individual words are processed serially (left to right), during later stages they are processed holistically (by sight). Therefore, in the evolving RAN–reading relationship, serial RAN accounts for serial within-word processes during earlier stages and for serial between-word processes during later stages.

In sum, recent comparisons of discrete and serial naming measures have confirmed that the latter are more strongly related to fluent reading and more diagnostic of reading difficulties. This general observation holds in languages varying greatly in orthographic transparency (English, Dutch, Greek, and Italian), so it is not a feature that is dependent on a specific grain size or depth of orthographic