Cognitive Psychology 68 (2014) 113–160

Contents lists available at ScienceDirect

Cognitive Psychology

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

Individual differences in reading aloud: A mega-study, item effects, and some models

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ARTICLE INFO

Article history:
Accepted 2 November 2013
Available online 2 December 2013

Keywords:
Visual word recognition
Word naming
Individual differences
Computational modelling
Reading aloud

ABSTRACT

Normal individual differences are rarely considered in the modelling of visual word recognition – with item response time effects and neuropsychological disorders being given more emphasis – but such individual differences can inform and test accounts of the processes of reading. We thus had 100 participants read aloud words selected to assess theoretically important item response time effects on an individual basis. Using two major models of reading aloud – DRC and CDP+ – we estimated numerical parameters to best model each individual's response times to see if this would allow the models to capture the effects, individual differences in them and the correlations among these individual differences. It did not. We therefore created an alternative model, the DRC-FC, which successfully captured more of the correlations among individual differences, by modifying the locus of the frequency effect. Overall, our analyses indicate that (i) even after accounting for individual differences in general speed, several other individual difference in reading remain significant; and (ii) these individual differences provide critical tests of models of reading aloud. The database thus offers a set of important constraints for future modelling of visual word recognition, and is a step towards integrating such models with other knowledge about individual differences in reading.

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http://dx.doi.org/10.1016/j.cogpsych.2013.11.001

1. Introduction

The identification of individual words is one important component of reading, and one that has been subject to extensive empirical studies, and also theoretical work in the form of computationally explicit implemented models. One of the most extensively modelled tasks is word naming (or reading aloud), in which participants read aloud words or pseudowords presented in isolation. The major empirical phenomena that models have addressed are impaired reading – found in acquired and developmental dyslexia – and *item effects*. Item effects are comparisons between words that differ on some specific dimension, such as length or frequency, usually in terms of response times (RTs).

According to the developers of models such as the dual-route cascaded model (DRC; Coltheart, Curtis, Atkins, & Haller, 1993; Coltheart, Rastle, Perry, Langdon, & Ziegler, 2001) and the connectionist dual process model (CDP+; Perry, Ziegler, & Zorzi, 2007; Zorzi, Houghton, & Butterworth, 1998), and to those who compare models to data (e.g., Adelman & Brown, 2008a; Besner, 1999; Reynolds & Besner, 2002, 2004), the goal of such modelling is a complete[1] and detailed account of human visual word recognition, which is indexed by a precise correspondence to the observed data. Whilst our understanding of impairments to reading has informed theories of visual word recognition, the constraints from these data are at a relatively high level. Consequently, the finer details of word recognition processes have been more readily examined using item effects shown by the average of a population of (mostly unimpaired, young adult) undergraduate readers (but see Ziegler et al., 2008, for an exception).

1.1. Average data and individual differences

1.1.1. Importance of individual differences

This concentration on average effects in skilled readers has been an important source of progress, but one could also raise the concern that this focus if it stood alone would be too narrow for models that seek to be a complete explanation of word recognition, because of individual differences in reading. One such concern is practical: Knowledge about word recognition can be applied to educational settings, including reading difficulties. If this knowledge included a theoretical understanding of individual differences in reading, this might be applied in the development of individual reading (and reading-related) education programmes, tailored to the cognitive strengths and weaknesses of the individual student. A related concern is that the array of knowledge from developmental studies of individual differences in reading renders the scope of models that do not account for individual differences incomplete.

1.1.2. Misleading nature of average data

Moreover, it is well-known that average performance patterns can differ from the average's constituent patterns of performance (e.g., Brown & Heathcote, 2003; Estes, 1956).

1.1.3. Inferences from individual differences

In any case, patterns of individual differences in performance may simply form additional constraints on models, giving indications as to the correct accounts of the item effects that might not emerge from the average item effects. Such indications may come because of the implications of common loci of effects. For instance, some effects – length and position of irregularity – are attributed by models such as DRC and CDP+ to the left-to-right sequential processing in spelling-sound conversion. If this is the case, these effects should be susceptible to the same causes of individual differences, and those individuals who are particularly susceptible to one effect will also be particularly susceptible to the other, inducing a correlation in the sizes of the effects. In contrast, effects attributed to separate components, such as length and frequency might be expected to show no such relationship, or a negative relationship if there is some trade-off in emphasis between the components.

[1] Although as the science progresses, models will be in some way incomplete – for instance, these models lack semantic processes – the goal of completeness means that phenomena that the models were not designed to explain can be used to test these posited details.