Journal of Experimental Child Psychology 115 (2013) 1–15

Contents lists available at SciVerse ScienceDirect

Journal of Experimental Child Psychology

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

Poor phonemic discrimination does not underlie poor verbal short-term memory in Down syndrome

Harry R.M. Purser [a,*], Christopher Jarrold [b]

[a] School of Psychology, Criminology, and Sociology, Faculty of Arts and Social Sciences, Kingston University, Kingston KT1 2EE, UK
[b] School of Experimental Psychology, University of Bristol, Clifton, Bristol BS8 1TU, UK

ARTICLE INFO

Article history:
Received 31 October 2012
Revised 24 December 2012
Available online 28 February 2013

Keywords:
Down syndrome
Memory
Short-term memory
Verbal
Language
Phonological
Phonemic discrimination
Recognition

ABSTRACT

Individuals with Down syndrome tend to have a marked impairment of verbal short-term memory. The chief aim of this study was to investigate whether phonemic discrimination contributes to this deficit. The secondary aim was to investigate whether phonological representations are degraded in verbal short-term memory in people with Down syndrome relative to control participants. To answer these questions, two tasks were used: a discrimination task, in which memory load was as low as possible, and a short-term recognition task that used the same stimulus items. Individuals with Down syndrome were found to perform significantly better than a nonverbal-matched typically developing group on the discrimination task, but they performed significantly more poorly than that group on the recognition task. The Down syndrome group was outperformed by an additional vocabulary-matched control group on the discrimination task but was outperformed to a markedly greater extent on the recognition task. Taken together, the results strongly indicate that phonemic discrimination ability is not central to the verbal short-term memory deficit associated with Down syndrome.

Introduction

Individuals with Down syndrome (DS) tend to perform poorly on tests of verbal short-term memory (Mackenzie & Hulme, 1987; Marcell & Armstrong, 1982; Marcell & Weeks, 1988). This deficit is

* Corresponding author.
E-mail address: h.purser@kingston.ac.uk (H.R.M. Purser).

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http://dx.doi.org/10.1016/j.jecp.2012.12.010

reflected by the relatively poor performance of people with DS on the digit span task, in which participants listen to a series of digits spoken by an experimenter and then attempt to repeat them back in serial order. Numerous studies have shown that the digit spans of individuals with DS are poorer than those of matched control participants (Jarrold & Baddeley, 1997; McDade & Adler, 1980; see also Næss, Lyster, Hulme, & Melby-Lervåg, 2011). Individuals with DS have also been found to perform more poorly on verbal short-term memory tasks than control participants when matched for performance on nonverbal short-term memory tasks (Brock & Jarrold, 2004; Jarrold & Baddeley, 1997; Jarrold, Baddeley, & Hewes, 1999; Jarrold, Baddeley, & Phillips, 2002; Purser & Jarrold, 2005), indicating that this deficit is specific to the verbal modality.

This deficit in verbal short-term, or phonological, memory may give rise to further cognitive deficits. Baddeley and colleagues (Baddeley, Gathercole, & Papagno, 1998; Gathercole & Baddeley, 1990) have argued that phonological memory might play a causal role in vocabulary acquisition and language comprehension. Although direct evidence for this suggestion in the context of Down syndrome is rare (Laws, 1998; Mosse & Jarrold, 2011), language abilities, and expressive language abilities in particular, are poorer in individuals with DS than predicted by their general cognitive abilities (e.g., Chapman, 1995, 1997; Fowler, 1990; Næss et al., 2011).

However, Hulme and Roodenrys (1995) argued that, in contrast to Baddeley and colleagues' suggestion, the verbal short-term memory deficit associated with DS might be a consequence of language difficulties because performance on phonological memory tasks is influenced by general language abilities. Successful performance on verbal short-term memory tasks is likely to depend on the ability to encode phonological representations (cf. Brady, 1997) because one cannot correctly output an item from memory that was not correct at the input to that memory system. Metsala (1999) argued that typically developing children's phonological representations emerge as a consequence of vocabulary development. In this way, the general language delay shown by individuals with DS could result in relatively poor phonological discrimination skills and, consequently, poor verbal short-term memory performance.

Phonological awareness does appear to be an area of relative difficulty for individuals with DS. Recently, Roch and Jarrold (2008) assessed the phonological awareness skills of a DS group, and reading-matched controls, with three paradigms. One was initial sound detection, where participants attempted to match a target picture to one of three response pictures on the basis of sharing the same initial sound (e.g., "Which starts with the same sound as *bee*—*table*, *bed*, or *sun*?"). Another was phoneme deletion, which was presented in a similar fashion; the task involved deciding which of three pictures would match the sound of the target picture following a particular deletion (e.g., "If *d* is removed from *deer*, which would match—*door*, *eye*, or *ear*"?). The remaining task was rhyme detection, in which participants tried to decide which of three response pictures rhymed with a target picture. Although the DS group performed more poorly than controls on each phonological awareness task, the DS group demonstrated particular difficulties on the rhyme detection test, in line with other studies (Cardoso-Martins, Michalick, & Pollo, 2002; Snowling, Hulme, & Mercer, 2002, see also Næss, Melby-Lervåg, Hulme, & Lyster, 2012).

Another aspect of phonological awareness is phonemic discrimination, sometimes referred to as segmental awareness. Phonemic discrimination abilities of individuals with DS were investigated by Brock and Jarrold (2004) with an item discrimination task similar to that developed by Bridgeman and Snowling (1988). In this task, participants were auditorily presented with pairs of words or nonwords and then asked to respond as to whether the two items were the same or different. The task performance of the DS group was found to be impaired relative to that of the control participants. However, there was a possible limitation of the discrimination task used; the participants needed to hold two items in memory and access the phonemic features of both simultaneously to be successful at the task. Given that individuals with DS show impaired verbal short-term memory, relatively poor performance on the task may simply reflect poor memory ability. Thus, it remains possible that individuals with DS do not have a particular impairment of phonemic discrimination ability. Furthermore, it is possible that any group that scores poorly on a test of phonemic discrimination—or indeed any measure of phonological awareness more generally—might do so because of poor verbal short-term memory if the test makes demands on that system (see Ramus & Szenkovits, 2008, for a detailed discussion of how findings of phonological discrimination can depend on noncentral task demands).