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Demonstrating the effects of phonological similarity and frequency on item and order memory in Down syndrome using process dissociation

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ABSTRACT

It is important to distinguish between memory for item information and memory for order information when considering the nature of verbal short-term memory (vSTM) performance. Although other researchers have attempted to make this distinction between item and order memory in children, none has done so using process dissociation. This study shows that such an approach can be particularly useful and informative. Individuals with Down syndrome (DS) tend to experience a vSTM deficit. These two experiments explored whether phonological similarity (Experiment 1) and item frequency (Experiment 2) affected vSTM for item and order information in a group of individuals with DS compared with typically developing (TD) vocabulary-matched children. Process dissociation was used to obtain measures of item and order memory via Nairne and Kelley's procedure (*Journal of Memory and Language, 50* (2004) 113–133). Those with DS were poorer than the matched TD group for recall of both item and order information. However, in both populations, phonologically similar items reduced order memory but enhanced item memory, whereas high-frequency items resulted in improvements in both item and order memory—effects that are in line with previous research in the adult literature. These results indicate that, despite poorer vSTM performance in DS, individuals experience phonological coding of verbal input and a contribution of long-term memory knowledge to recall. These findings inform routes for interventions for those with DS, highlighting the need to enhance both item and

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order memory. Moreover, this work demonstrates that process dissociation is applicable and informative for studying special populations and children.

Introduction

Verbal short-term memory (vSTM) refers to the limited capacity system for the storage and maintenance of short-term verbal information. A distinction between vSTM for item information and for order information is acknowledged in the literature (Bjork & Healy, 1974; Brown, Preece, & Hulme, 2000; Burgess & Hitch, 1992); thus, it is beneficial to explore both of these components to effectively understand the nature of vSTM. Research has implicated a role of vSTM in syntax acquisition (Ellis & Sinclair, 1996), language comprehension (Vallar & Baddeley, 1984), and possibly reading and mathematics development (Gathercole, Pickering, Knight, & Stegmann, 2004; Leather & Henry, 1994). The link between vSTM and vocabulary acquisition is particularly well established (Baddeley, Gathercole, & Papagno, 1998; Baddeley, Papagno, & Vallar, 1988; Gathercole & Baddeley, 1990; Papagno, Valentine, & Baddeley, 1991). Studies have shown superior receptive vocabulary in individuals with better vSTM skills (Gathercole, Service, Hitch, Adams, & Martin, 1999; Gathercole, Willis, Emslie, & Baddeley, 1992) as well as superior new word learning ability (Gathercole, Hitch, Service, & Martin, 1997; Jarrold, Baddeley, Hewes, Leeke, & Phillips, 2004) and superior second language acquisition (Service, 1992) in these individuals. Furthermore, Baddeley and colleagues (1988) provided neurological evidence for the role of vSTM in the learning of new phonological forms. Whereas some researchers have suggested that verbal memory and language problems are simply likely to co-occur, with the former being an inevitable consequence of the latter (Hulme & Roodenrys, 1995; Van der Lely & Howard, 1993), other evidence supports the notion that experiencing a vSTM deficit may have a causal effect on these related domains such as vocabulary and syntax (Gathercole & Baddeley, 1990; Jarrold et al., 2004). This shows the need to understand vSTM and to distinguish between item and order memory contributions to these relationships (Majerus, Metz-Lutz, Van der Kaa, Van der Linden, & Poncelet, 2007; Majerus, Poncelet, Greffe, & Van der Linden, 2006a).

One population among whom vSTM problems are extremely common is those with Down syndrome (DS). DS is the most prevalent of genetic developmental disorders in the population worldwide, with an approximate prevalence of 1 in every 737 live births (Parker et al., 2010), and is caused by an extra copy (either complete or partial) of chromosome 21. Intellectual ability level varies widely in those with DS (Tsao & Kindelberger, 2009), with individuals experiencing varying degrees of general learning difficulties. However, beyond this, evidence consistently points to a tendency toward specifically poorer vSTM in this population (Jarrold & Baddeley, 1997; Jarrold, Baddeley, & Hewes, 2000) that becomes apparent during childhood (Chapman & Hesketh, 2001). Although not strictly observed in every single individual with DS (Vallar & Papagno, 1993), this very common tendency for poorer vSTM performance is relative to performance in comparable visuospatial STM tasks and compared with matched control groups of both typically developing children and other learning-disabled groups (Brock & Jarrold, 2005; Hulme & Mackenzie, 1992; Jarrold & Baddeley, 1997; Jarrold, Cowan, Hewes, & Riby, 2004; Jarrold et al., 2000; Laws & Bishop, 2003; Vicari, Marotta, & Carlesimo, 2004).

Impairments in vocabulary are also observed in individuals with DS; however, there is an apparent distinction, whereby receptive vocabulary ability is relatively less impaired (Chapman, Bird, & Schwartz, 1990; Laws, 1998), in contrast to greater impairments in expressive vocabulary (Næss, Lyster, Hulme, & Melby-Lervåg, 2011). Chapman (1995) suggested that expressive language problems in particular may be a result of poorer vSTM (see also Jarrold, Thorn, & Stephens, 2009). Chapman and Hesketh (2001) argued, on the basis of longitudinal modeling, that vSTM contributed to both receptive and expressive language in DS but that age and visual memory also contributed to receptive but not expressive language. Research by Mosse and Jarrold (2008), Mosse and Jarrold (2010) also indicates