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Longitudinal relationships between language and verbal short-term memory skills in children with Down syndrome

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ABSTRACT

Children with Down syndrome are at risk for language difficulties, the nature of which is not well understood. This study compared the longitudinal predictors of language skills in children with Down syndrome with those in typically developing control children matched for initial level of nonverbal mental ability. An age cohort of children with Down syndrome (n = 43) and 57 typically developing control children was assessed on measures of vocabulary, grammar, and verbal short-term memory three times at yearly intervals. Children with Down syndrome showed slower development on all measures than the typically developing controls. Longitudinal analyses showed moderate to high stability of language and verbal short-term memory skills. Our results confirm earlier evidence of pervasive language learning difficulties in this group and suggest that early language intervention should be given high priority.

Introduction

Language is a fundamental skill that has potentially widespread influences on other aspects of cognitive development as well as social interaction. Children with Down syndrome typically experience

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severe language learning difficulties (Næss, Lyster, Hulme, & Melby-Lervåg, 2011), but the pattern of their development across different domains of language is not well understood. This study explored language development in an age cohort of 43 children with Down syndrome. We compared the progress of these children with that of a group of 57 typically developing control children matched for initial level of nonverbal mental ability and investigated the longitudinal predictors of language development in both groups.

Several cross-sectional studies of the development of language and verbal short-term memory skills in children with Down syndrome have been conducted. These studies suggest that vocabulary may be a relative strength compared with other language domains (e.g., Laws & Bishop, 2003), although some studies also show contradictory results (e.g., Price, Roberts, Vandergrift, & Martin, 2007). Few studies of children with Down syndrome have provided any information about how vocabulary, grammar, and verbal short-term memory skills change over time or have examined longitudinal predictors of development. Overall, evidence is consistent in showing extremely slow development of verbal short-term memory skills in children with Down syndrome (e.g., Chapman, Hesketh, & Kistler, 2002; Hick, Botting, & Conti-Ramsden, 2005), but the pattern of growth in vocabulary and grammatical skills from these same studies is not clear. The lack of conclusive findings may be caused by a variety of methodological issues such as the frequency of data collection, small sample sizes, and the wide ranges of age and nonverbal ability within the samples. In addition, the procedures used, including the use of matching variables or types of scores, may complicate the interpretation of the findings. Few studies have focused on these potential methodological difficulties, and few studies have involved age cohorts of children with Down syndrome. However, a cross-sectional parental report study by Berglund, Eriksson, and Johansson (2001) included 330 children with Down syndrome from 1 to 5 years of age and found that chronological age significantly correlated with language skills. In addition, a 5-year follow-up study by Laws and Gunn (2004), which used clinical tests and statistically controlled for chronological age, found that individual differences in language development were related to variations in age. Studies not controlling for chronological age, therefore, may produce unreliable results. The current study is unique in using a nonverbal mental age match design and following the development of vocabulary, grammar, and verbal short-term memory skills in a group of children with Down syndrome in a narrow age range (12 months).

Verbal short-term memory and vocabulary development

The possible influence of verbal short-term memory (as measured by tasks of nonword repetition, word span, and sentence repetition) on vocabulary development is controversial. According to the phonological storage hypothesis (Gathercole, 2006; Gathercole & Baddeley, 1990; Gathercole, Willis, Emslie, & Baddeley, 1992), permanent phonological memory records of words are built up by abstracting representations from the temporary retention of sound patterns held in a "phonological loop." In this view, deficits in phonological storage are a possible cause of deficits in vocabulary development. In contrast to the phonological storage hypothesis, the phonological sensitivity hypothesis (Metsala & Christholm, 2010; Metsala, Stavrinos, & Walley, 2009; Munson, Kurtz, & Windsor, 2005; Snowling, Chiat, & Hulme, 1991) suggests that acquiring lexical representations for many words results in the development of phonemically structured phonological representations, and such well-structured representations are, in turn, helpful for verbal short-term memory.

Both the phonological storage hypothesis and the phonological sensitivity hypothesis have been criticized. One criticism of the phonological storage hypothesis is that many of the research studies testing this hypothesis involve concurrent data (e.g., Gathercole, Service, Hitch, Adams, & Martin, 1999; Majerus & Boukebza, 2013) that cannot identify the direction of any possible causal effects (Melby-Lervåg et al., 2012). Another related criticism is that the results from the few existing longitudinal studies have been distinctly mixed. Two studies (Bowey, 2001; de Jong & Olson, 2004) found no evidence that verbal short-term memory, assessed by nonword repetition at 5 years of age, was a longitudinal predictor of variations in vocabulary knowledge 1 year later. In contrast, a large-scale study by Gathercole and colleagues (1992) reported that nonword repetition ability at 4 years of age was a predictor of vocabulary development at 5 years (but not at later ages). However, based