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How cognitive factors affect language development in children with intellectual disabilities

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ABSTRACT

The present study investigated the language development of 50 children with intellectual disabilities (ID) and 42 typically developing children from age 4 to 5 years, and was designed to shed more light on the respective roles of phonological working memory (WM) and nonverbal intelligence in vocabulary and syntax development. Results showed that nonverbal intelligence predicted phonological WM, vocabulary and syntax of children with ID at age 4 and 5, and that it only predicted these skills at age 4 in typically developing children. Furthermore, syntax at age 5 was predicted by vocabulary at age 4 in children with ID, which points to children with ID requiring a larger critical mass of vocabulary for syntactic development to be initiated.

1. Introduction

The language development of children with intellectual disabilities (ID) often shows delays, and the cognitive disabilities of these children are thought to be the main cause of these delays (e.g., cognition hypothesis; Cromer, 1991). This view, however, seems to be too limited (Rondal, 2001). Although in many studies the language level has been found to be in pace with the mental age of the children with ID (Rondal, 2001), other studies found great variation in linguistic areas that develop faster or slower than could be expected based on the mental level of the children. For example, children with Down syndrome show specific weaknesses in the areas of speech production, syntax, and the intelligibility of their speech (Roberts, Price, & Malkin, 2007). On the other hand, some children with ID have vocabulary levels far above their mental age (Facon, Facon-Bollengier, & Grubar, 2002), and with appropriate support, children with ID can acquire high levels of communication and literacy skills (Kaiser, Hester, & McDuffie, 2001; Koppenhaver & Erickson, 2003; Van der Schuit, Segers, Van Balkom, Stoep, & Verhoeven, 2010).

These varying language levels of children with ID raise the question of what the influence of different levels of intelligence is on the language development of children. Not all studies have found developmental level to be predictive of later language skills (Calandrella & Wilcox, 2000; McCathren, Yoder, & Warren, 1999), while others did not include intelligence measures as predictors of language development. Often, studies only included children with the same etiology (e.g., Down syndrome), which gives valuable information about strengths and weaknessess of the specific syndrome, but does not shed further light on the influence of intelligence on language development of all children with low intelligence. The present study, therefore,

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included children with a range of etiology to shed more light on the influence of intelligence levels on the language development of children with ID and their typically developing peers.

Children need several cognitive functions through which they acquire the language aspects that enable them to become competent language users. First, children need to learn how to segment the stream of speech sounds they hear into meaningful language units (e.g., words). This phonological development requires a certain amount of cognitive control from children, although it happens mostly implicit and without conscious awareness (Conway & Pisoni, 2008). Especially working memory (WM) plays a major role in language acquisition, as it allows for short-term storage or rehearsal of information, which is known to support long-term storage (Baddeley, 1986; Ellis & Sinclair, 1996). WM consists of three systems, namely the central executive, which serves as an attentional controller, and two separate systems for short-term storage of visuospatial and phonological information (i.e., the visuospatial sketchpad and the phonological loop). The phonological loop, in which phonological information can be stored and rehearsed for a short period of time, has been found to be the most important system of WM for language learning (Baddeley, 1986; Baddeley, Gathercole, & Papagno, 1998; Conway & Pisoni, 2008). Strong correlations exist between phonological WM and vocabulary and syntax skills of typically developing children (Baddeley et al., 1998). Children who are better in non-word repetition learn new vocabulary at a faster rate (Gathercole & Baddeley, 1990), and children with better phonological WM skills also show better syntax skills (e.g., longer and more complex sentences) (Adams & Gathercole, 1995).

Secondly, children need to learn that language sounds represent certain objects or actions. Around the age of 18 months, children start to sort objects into categories (Gopnik & Meltzoff, 1987, 1992). The ability to categorise objects marks an important shift in children's cognitive development, and it is thought to be the moment that children start to realize that each object belongs to a category. This new realization is also associated with an increase in the rate with which new words are learned (Gopnik & Meltzoff, 1987; Gopnik & Meltzoff, 1992; Mandler, 2004). Children's first words are learned in a more associationist mode, with children linking the sound patterns they hear to specific objects or actions after repeatedly being presented together (Nazzi & Bertoncini, 2003). This is a time-consuming process, with a slow learning rate, and children may use words only in specific situations or for specific objects. The moment (around 18 months) children learn that objects can be categorized and that different objects and events each have their own *label*, is typically seen when children have around 50–100 productive words. At the same moment, there is a 'vocabulary burst', with children adding up to seven new words per day to their vocabularies (Fenson et al., 1994).

This 'vocabulary burst' is typically accompanied by the onset of syntactic development, as at this point the first word combinations also appear. A certain level of lexical development is thus needed in order to have syntactic development initiated; this is referred to as the 'critical mass hypothesis' (Bates & Goodman, 1997; Marchman & Bates, 1994). The development of syntax has indeed been found to begin at the time children actively use a minimum of 50–100 words. At first, children's syntactical knowledge is organized around specific words, early gesture-word combinations, and formulaic phrases or so-called templates, from which they later abstract more general patterns to then be applied to new words and meanings (Akhtar, 1999; Lieven, Pine, & Baldwin, 1997; Tomasello, 2003).

In typical language development, the early development of vocabulary and syntax are thus highly interdependent (Dionne, Dale, Boivin, & Plomin, 2003). This process, in which abilities on one language skill predict the development of other language skills, is called bootstrapping (Gleitman, 1990). First, until 2 years 6 months, lexical bootstrapping is mostly observed, with lexical development predicting grammatical development (Bates & Goodman, 1997; Marchman & Bates, 1994). Then syntactic bootstrapping becomes dominant, with syntactic knowledge facilitating later lexical development (Jones Moyle, Ellis Weismer, Evans, & Lindstrom, 2007). During later language development (after 3 years and 6 months) these two components appear to be less strongly related, and the development of these components becomes more autonomous (Bates & Goodman, 1997).

It remains unclear, however, whether such bootstrapping mechanisms can also be observed in children with ID. For children with ID, lower general levels of intelligence can interfere with the ability to categorise objects and as a result hinder further lexical development. While vocabulary development often keeps up with mental age, it can be suggested that, although delayed, most children with ID seem to follow the same developmental pathways as typically developing children. It has indeed been found that, at least in children with Down syndrome, the vocabulary spurt and the ability to categorise objects occur at the same time (Mervis & Bertrand, 1997). However, for children with Williams syndrome, atypical developmental trajectories have been observed. For these children, the vocabulary spurt often precedes the ability to categorise objects (Mervis & Bertrand, 1997), and sometimes, in spite of large vocabularies, the categorizing abilities seen in typically developing infants are still not observed in children with Williams syndrome in adulthood (Stevens & Karmiloff-Smith, 1997). It is suggested that children with Williams syndrome continue to acquire their lexicon through an associationist mode, in which they link the sound patterns they hear to specific objects or actions after repeatedly being presented together (Nazzi & Bertoncini, 2003). This highlights the importance of the other cognitive factor, phonological WM, for language development.

Similar to typically developing children, there is a strong relationship between phonological WM and vocabulary in children with ID (Jarrold, Baddeley, Hewes, Leeke, & Phillips, 2004). However, children with ID have difficulties with tasks involving phonological WM (Jarrold & Baddeley, 1997; Van der Molen, Van Luit, Jongmans, & Van der Molen, 2007). They have lower WM skills, both in phonological and visuospatial storage, than same-aged typically developing children. The phonological WM of children with ID seems to be more affected than visuospatial memory, because when compared to younger typically developing children with the same mental age, children with ID performed better on the visuospatial memory tasks, but worse on the word span task (Henry & Maclean, 2002). Within the group of children with ID, especially