

# Before and after the vocabulary spurt: two modes of word acquisition?

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## Abstract

*This paper focuses on early lexical development, and especially the period around 18 months known as the vocabulary spurt. We first propose that this period corresponds to a shift from an associationist to a referential lexical acquisition mechanism following the developmental coupling of specific pre-linguistic and cognitive abilities. This latter mechanism would allow the acquisition of genuine words, i.e. links between phonetically specified sound patterns and object categories. We then review the literature on early lexical acquisition by typically developing infants and infants with Down and Williams syndrome, and report some data that were recently collected on this issue. We conclude that the data so far are congruent with our proposal, but because they remain insufficient, we propose some future research that focuses on the relation between pre-linguistic and cognitive developments.*

## Introduction

The past decades of infancy research have demonstrated the extent to which speech perception develops during the first year of life, going from unspecified/language general processes, to processes attuned to the infant's native language (Jusczyk, 1997). These developments lay out the ground for the subsequent acquisition of higher levels of language. Vocabulary acquisition, on which the present paper focuses, starts around 12 months, as attested by parental reports and observational studies (Barrett, 1995; Benedict, 1979; Clark, 1993; Huttenlocher, 1974; Ingram, 1989; Nelson, 1973; Oviatt, 1980), and experimental studies of word comprehension (Hallé & de Boysson-Bardies, 1994; Tincoff & Jusczyk, 1999) or word acquisition (Hollich, Hirsh-Pasek & Golinkoff, 2000; Mervis & Bertrand, 1994; Schafer & Plunkett, 1998; Werker, Cohen, Lloyd, Casacola & Stager, 1998; Woodward, Markman & Fitzsimmons, 1994). Although vocabulary growth is initially very slow, one or two newly produced words a week up to 50 words, it suddenly speeds up around 18 months (the vocabulary spurt), infants producing up to nine new words a day (Benedict, 1979; Carey, 1978; Goldfield & Reznick, 1990; Nelson, 1973). Note that the vocabulary spurt is defined by

changes in lexical production, but that recent neurophysiological data suggest changes in lexical comprehension processes around that same age (Mills, Coffey-Corina & Neville, 1997).

For a few authors, the vocabulary spurt corresponds to changes in abilities to produce words not directly linked to lexical acquisition itself, such as increased lexical memory abilities, increased motivation to communicate with the environment, and developments in articulatory abilities (see Woodward *et al.*, 1994). However, the predominant view is that the vocabulary spurt reflects qualitative changes regarding the nature of the lexicon and the way words are acquired. Accordingly, the spurt was proposed to mark the beginning of the referential use of language (Lock, 1980; McShane, 1979), a qualitative transition between learning words one at a time and learning a language (Goldfield & Reznick, 1996), or the emergence of constraints on lexical acquisition (Clark, 1983; Golinkoff, Mervis & Hirsh-Pasek, 1994; Markman, 1989; Merriman & Bowman, 1989). It was further proposed that the vocabulary spurt is related to cognitive developments in object permanence knowledge (Corrigan, 1978), the ability to represent objects (Lifter & Bloom, 1989), to form concepts (Nelson & Lucariello, 1985) and to categorize objects (Gopnik & Meltzoff, 1987, 1992).

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### Working hypothesis: pre-linguistic/cognitive coupling

We present a number of hypotheses, based on previous qualitative interpretations of the vocabulary spurt, intended to offer a more explicit and testable account of that developmental period. They revolve around what we think a genuine word is: the pairing between a phonetically specified sound pattern and a concept. Limiting our discussion to count nouns, a word is a pairing between a sound pattern and a category of objects. We propose that the infant's first words do not constitute words *per se*, but rather 'proto-words' corresponding to the pairing of an underspecified sound pattern and a specific object. The first 'genuine' words would appear with the vocabulary spurt.

We further propose that these two types of words are acquired through radically different mechanisms. Proto-words would be learnt through a mechanism linking phonetically underspecified sound patterns to specific objects following their repeated simultaneous presentations. For the more familiar proto-words, these links could later be extended to a small number of exemplars of the target category on a case-by-case basis. On the other hand, genuine words would be acquired through the immediate pairing of a phonetically specified sound pattern to an unnamed object category (at the child-basic level at first). Hence, the vocabulary spurt would signal a shift from a purely associationist mode of acquisition (linking of two events occurring simultaneously) to a referential mode of acquisition (language as a way of representing the world).

Finally, we propose that the vocabulary spurt might correspond to the onset of linguistic development *per se*. This onset would result from the developmental coupling of a pre-linguistic ability (the forming of sound pattern representations) and a cognitive ability (the forming of exhaustive object categories) around 18 months. More precisely, the emergence of spontaneous exhaustive categorization would allow sound patterns to start being attached directly to the referent object categories, rather than the specific object seen by the infant. The emergence of this referential mechanism would produce an economy in processing time/working memory, because the word–category pairing would then only need to be learnt once (rather than for each exemplar). This would allow an increase in the rate at which new words are learnt, giving rise to the vocabulary spurt. It would also allow infants to devote more attention to phonological information while learning a word, hence allowing the use of phonetically specified sound patterns at the lexical level.

### Changes related to lexical acquisition at 18 months

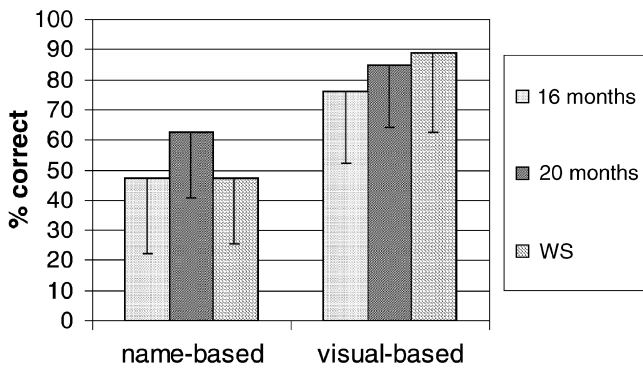
The literature review below evaluates whether the vocabulary spurt at about 18 months might mark a change in the mechanisms responsible for lexical acquisition, focusing on proposed changes in infants' abilities to build object categories, to pair new sound patterns to unnamed categories and to use phonetically specified sound patterns.

#### *Cognitive developments in object categorization*

Infants show object categorization behaviors from a very young age. Perceptual-based object categorization is found as early as 4 months (see Quinn & Eimas, 1997), there is some (scarce) indication of conceptual categorization before 12 months (see Mandler, 2000) and a lot of evidence that categorization evolves throughout infancy and childhood (Mareschal, 2000; Nazzi & Gopnik, 2000; Younger & Cohen, 1986). One important change in categorization abilities, evidenced in manual sorting tasks, happens around 18 months and corresponds to the emergence of exhaustive categorization. Unlike earlier categorization behavior, exhaustive categorization cannot be explained by visual preference for one kind of stimulus. Importantly, it has been described as the ultimate development of perceptual categorization, the moment when infants realize that every object belongs to a category (Gopnik & Meltzoff, 1987, 1992; Mervis & Bertrand, 1994).

#### *Changes in linking sounds and object categories*

A first line of research relevant to the issue of the linking between sound patterns and object categories has looked at the influence of naming on object categorization, and established that naming enhances 13-month-olds' object categorizations (Waxman & Markow, 1995). However, this effect of naming might be limited to well-known object categories, and might not apply to the context of the acquisition of new words. Consequently, Nazzi and Gopnik (2001) have looked at the emergence of infants' ability to form new name-based categories after only a few repetitions of the labels. Infants were presented with triads of objects, two of which were labeled 'tib' and the third one 'dak'. After this presentation phase, the experimenter picked up one of the two objects with the same name, and asked the infant to give him 'the one that goes with this one'. Twenty-month-old infants, but not 16-month-olds, succeeded at that task (while both age groups could perform a similar task when the objects had to be categorized according to their visual properties),



**Figure 1** Categorization performance (and standard deviations) on name- and visual-based trials for typically developing infants (data from Nazzi & Gopnik, 2001), and young children with Williams syndrome (data from Nazzi & Karmiloff-Smith, 2002).

suggesting that this ability emerges between 16 and 20 months (see Figure 1).

A second line of research investigated infants' ability to rapidly learn new links between sound patterns and objects, and found this ability present in infants as young as 12–15 months (Hollich *et al.*, 2000; Shafer & Plunkett, 1998; Werker *et al.*, 1998; Woodward *et al.*, 1994). However, these studies do not provide strong evidence that the infants might be linking sound patterns to object categories as opposed to specific objects because label generalization was tested with objects differing from the original objects in color only (Woodward *et al.*, 1994). Finally, note that infants who are taught a new word in the presence of several named objects and one unnamed object start pairing the new sound pattern to the unnamed object around 18 months (Mervis & Bertrand, 1994).

#### *Evolution of the precision of sound pattern representations*

Studies on young infants' ability to segment sound patterns from fluent speech suggest that these patterns are phonetically specified as early as 7.5 months (Jusczyk & Aslin, 1995), and prosodically specified at least by 13.5 months (Nazzi, Jusczyk & Bhagirath, 1999). However, phonetically specified patterns do not seem to be used in early word learning. Indeed, sound patterns of familiar words seem to be phonetically underspecified at 11–12 months (Hallé & de Boysson-Bardies, 1996). Moreover, 14-month-olds cannot learn two new words simultaneously if they differ by only one phonetic feature (Stager & Werker, 1997). This seems to have changed by 20 months (Fennell, Corcoran & Werker, 2000), and further

evidence for the use of phonetically specified sound patterns after 18 months comes from research on the production (Plunkett, 1993) and recognition (Swingley & Aslin, 2000; Swingley, Pinto & Fernald, 1999) of familiar words.

### **Eighteen months of age: A time of linked developments**

We now review evidence regarding the precise sequence in which the changes reviewed above take place, and their link to the vocabulary spurt. We proposed that changes in object categorization precede the emergence of the ability to link sound patterns and object categories, which precedes the naming spurt, which precedes the emergence of the use of phonetically specified sound patterns.

First, studies on exhaustive categorization show that it emerges either simultaneously or before the vocabulary spurt (Gopnik & Meltzoff, 1987, 1992; Mervis & Bertrand, 1994). Importantly, the age at which the spurt occurred correlated with the emergence of exhaustive categorization, but not with that of other cognitive abilities such as means–ends and object permanence tasks. This suggests a specific link between the emergence of exhaustive categorization and the vocabulary spurt.

Second, two studies explore the link between the emergence of the ability to link sound patterns to object categories and vocabulary development. Mervis and Bertrand (1994) have shown a temporal link between the ability to attach new names to unnamed categories, the emergence of exhaustive categorization and the naming spurt. Infants succeeding with the attachment tended to have larger vocabularies and to perform exhaustive categorization. Infants failing to attach were retested after attaining the vocabulary spurt, and found to succeed with the attachment and be able to categorize exhaustively. Nazzi and Gopnik (2001) have shown that the ability to form name-based categorizations (which seems to emerge between 16 and 20 months) is linked to productive vocabulary size rather than visual-based categorization performance, again suggesting the existence of a specific developmental link. Indeed, at 20 months of age, there was a strong positive correlation between name-based categorization and the size of productive vocabulary, while there was a non-significant trend of a negative correlation between performance on name- and visual-based categorization. Finally, although the order of emergence of name-based categorization and the vocabulary spurt could not be determined due to the cross-sectional design of the study, the vocabulary measures suggested that most 16-month-olds had not yet gone

through the vocabulary spurt (vocabulary size:  $M = 28$ , range 4–80), while most 20-month-olds had (vocabulary size:  $M = 141$ , range 17–397).

In summary, the above results are consistent with our proposal that the developmental coupling of pre-linguistic and cognitive abilities around 18 months might result in changes in lexical acquisition mechanisms and the vocabulary spurt. However, the evidence is too scarce and incomplete to provide a satisfactory validation of our proposal. Not all of the developmental sequence and all of the links between the different changes have been explored (especially regarding the use of phonetically specified sound patterns). We are currently starting a project assessing the gradual emergence of these abilities and their links in infants with typical development, using both longitudinal and cross-sectional designs. There is, however, another way to evaluate our developmental sequence hypothesis, and that is by looking at early vocabulary acquisition in populations of infants developing atypically.

### Early lexical acquisition by infants with Down or Williams syndrome

There are several ways in which the study of atypical development can inform us on typical development. Regarding lexical acquisition, it would first allow us to determine whether some components of the developmental sequence we proposed (and their timing) are crucial to lexical acquisition, or whether some variability is possible (as proposed by the neuroconstructivist hypothesis, see Karmiloff-Smith, 1998). If there is only one possible sequence, then only atypical populations following the typical developmental sequence would succeed in building a lexicon. Second, by choosing atypical populations that differ in the relative strength of their general levels of cognitive and language development, we would be able to explore the importance of the linking, around 18 months, between pre-linguistic and cognitive developments in typical lexical acquisition.

We were particularly interested in two genetic disorders that are both associated with moderate to severe mental retardation, but differ in their cognitive and linguistic abilities: Down syndrome (marked by a rather balanced developmental profile, though general cognitive development is slightly less impaired) and Williams syndrome (marked by an uneven cognitive profile, with areas of strength such as language and face processing, and marked weaknesses such as visuospatial constructive skills and number cognition).

In adulthood, these two atypical populations contrast in the linguistic abilities they achieve: rather poor for

individuals with Down syndrome, rather good for individuals with Williams syndrome. But infants from these two populations show large delays in lexical acquisition onset (many still do not really speak by 3 years of age) and, early on, equally poor lexical comprehension performance (Paterson, Brown, Gsoedl, Johnson & Karmiloff-Smith, 1999). This suggests that both populations encounter initial problems in acquiring a lexicon, but that these problems might have different origins and receive different solutions. In the following, we review the literature on lexical acquisition in Down and Williams syndrome, in the light of what we proposed the typical developmental trajectory might be.

Although the linguistic development of infants with Down syndrome is generally delayed, with many 3-year-olds that still hardly speak (Klein & Mervis, 1999; Singer, Bellugi, Bates, Jones & Rossen, 1997), it appears that exhaustive categorization, the ability to attach a new sound pattern to an object and the vocabulary spurt emerge simultaneously (Mervis & Bertrand, 1995). This is compatible with the idea that these infants follow a developmental trajectory delayed but similar to that of typically developing infants. However, this conclusion does not explain why they never reach good levels of vocabulary development. At this point, we can only speculate. One possible explanation is timing: the result of the linkage between pre-linguistic and cognitive abilities might produce a different outcome because of the delay with which it happens. Another non-exclusive possibility is that the auditory perception deficits of individuals with Down syndrome (Jarrold & Baddeley, 1997) might prevent them from efficiently using phonetically specified sound patterns. Further research will be needed to determine the exact sequence of development of the different abilities that we discussed, and whether that sequence is typical.

The evidence regarding infants with Williams syndrome suggests that they follow an atypical developmental sequence. Word production is more (rather than less) advanced than word comprehension (Singer *et al.*, 1997). The delayed vocabulary spurt often precedes (rather than follows) by up to 12 months the emergence of exhaustive categorization and of the ability to link sound patterns to unnamed objects (Mervis & Bertand, 1997). The ability to form name-based categories is still not developed by 4 years, in spite of large vocabularies (see Figure 1, and Nazzi, 2001; Nazzi & Karmiloff-Smith, 2002). Finally, some of the lexical constraints present in typically developing infants are still absent in adulthood (Stevens & Karmiloff-Smith, 1997). These results suggest that the difficulties encountered by infants with Williams syndrome in building object categories prevent the typical coupling of conceptual and

pre-linguistic developments, hence preventing the development of the referential lexical acquisition mechanism. Although this might explain their initial delays in lexical acquisition, it does not explain how they ultimately reach high levels of vocabulary development, and again we are left speculating. One possibility is that they develop alternative mechanisms, not seen in typical development: in which case, the typical lexical development path might be one among several alternative paths. Alternatively, capitalizing on good speech perception and memorization abilities (Karmiloff-Smith, Grant, Berthoud Davies, Howlin & Udwin, 1997; Vicari, Brizzolara, Carlesimo, Pezzini & Volterra, 1996), they might acquire a large 'proto-lexicon' (with several exemplars of a category being gradually attached to their appropriate sound pattern) by continuing using in childhood the associationist sound pattern-specific object mechanism.

## Conclusion

In conclusion, we have proposed that changes in early lexical acquisition correspond to a shift, around 18 months of age, from the acquisition of proto-words through an associationist mechanism to the acquisition of genuine words through a referential mechanism. In this view, genuine words constitute links between phonetically specified sound patterns and object categories. Our literature review and the study by Nazzi and Gopnik (2001) showed that the data on typically developing infants are consistent with our proposal, but do not constitute definite evidence. It also led to the surprising finding that infants with Down syndrome, who will develop poor lexical abilities, might initially follow the typical developmental path, while infants with Williams syndrome, who will develop good lexical abilities, seem to follow a radically different developmental path. We suggested, partly based on new data by Nazzi and Karmiloff-Smith (2002), that the results on Williams syndrome might point to possible alternative ways to acquire a lexicon. All this calls for more psychological and neurophysiological research to be conducted in the area of early lexical development, that would put an emphasis on the still relatively unexplored links between cognitive and (pre)-linguistic developments during the second year of life.

## Acknowledgements

The writing of this paper was supported by a grant from the Medical Research Council (Project grant number

G9809880) to Annette Karmiloff-Smith. We would like to thank Sarah Paterson for comments on an earlier version of the manuscript.

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Received: 8 August 2001

Accepted: 21 December 2001