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Some cognitive tools for word learning: the role of working memory and goal preference

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Abstract: We propose that Bloom's focus on cognitive factors involved in word learning is still lacking a broader perspective. The crucial relevance of working memory in learning elements of language is emphasized. Specifically, we demonstrate on that in impaired populations knowledge of some linguistic elements can be dissociated according to the type of working memory (visual or verbal) involved in a task. To take another aspect, Bloom's concentration on theory of mind as a precondition for word learning is certainly correct. However, theory of mind being a necessary condition does not make it a sufficient one. On the basis of our studies we point out the importance of a theory of mind related goal preference in acquiring spatial language. In general, we claim that more detailed cognitive preferences and constraints should be outlined for the preconditions of acquiring linguistic elements.
Keywords: goals, spatial language, working memory, Williams syndrome

In Bloom's detailed and well argumented concept of the acquisition of word meaning a rather ambitious general model is set up. According to this, both necessary and sufficient conditions for word learning are of a general nature - he speak about calculating intentions, concept formation, consideration of syntax, and “certain general learning and memory abilities” (p. 10). Rather than evaluating the general model which we highly esteem, our intention is to point out how one could elaborate some of these assumed “general abilities”.

Let us first imagine a child who would be entirely equipped with a functioning theory of mind, but lacking any storage system to temporarily store forms of items. The child would certainly know that sounds have a dual relationship to the world and to the mental state of the speaker, but would not be able to consolidate the signs due to his lack of memory. One has to suppose that in order to consolidate both form and meaning, one has to have a working memory system among those general memory abilities. This is trivial, of course, and is the cornerstone of basic assumptions about how working memory is used in learning new words. Individual differences in word learning and vocabulary and their relationship to working memory capacity have been aptly documented (Gathercole et al., 1992, 1997; Baddeley et al., 1998). Developmental pathology is of crucial interest in this regard.

In a study of ours (Lukács, Racsmány, and Pléh, 2001) we obtained some interesting dissociative relationships between vocabulary acquisition and working memory. As Table 1 shows, in Williams syndrome subjects of a wide age range (between 6 and 20 years) the best predictor for frequent words, was age of the subject. However, for the acquisition of rare words the best predictor was verbal working memory measured in digit span. This suggests that working memory is an important cognitive resource for putting words into the mind.

Table 1. Stepwise regression solutions for different vocabulary measures in Williams syndrome

Dependent variable	Regression coefficient	Equation	First R
Rare words	0.65	1.82 + 4.2 span	Span 0.65 F=8.59
Frequent words	0.75	29.18 + 0.51 age	Age 0.75 F=15.26

Interestingly, we also observed that a clear dissociation shows up between the acquisition of simple agreement related basic grammatical morphemes like plural and accusative, and spatial suffixes and postpositions, (Racsmány et al., 2001). In a task constructed by Pléh et al. (1994) we contrasted the knowledge of spatial and non-spatial inflectional forms in Williams syndrome children. As Table 2 shows, there is a clear dissociation in using spatial and non-spatial language ($T = 4{,}9$, $p<0.01$).

Table 2. Percentage of correctly used spatial and non-spatial morphological forms in Williams syndrome

Non-spatial grammatical morphemes	Spatial suffixes and postpositions
0.87	0.48**

Working memory capacity was a strong predictor of performance in morphological tasks. However, this time our analysis involved not only verbal working memory but spatial working memory capacities, as well. In a multiple regression analysis the two modality dependent working memory performances explained 93 percent of the variance of spatial morphological task performance ($F = 48,66$, $p<0,001$, Adjusted $R^2 = 0,93$). This result reveals that in the proces of spatial language learning, children have to keep in mind the phonological and the spatial information at the same time. Spatial and verbal working memory capacity give crucial constraints for the rate and the level of spatial language learning.

There is another aspect where we would like to enrich the picture presented by Bloom. In present day infant studies several lines of research have demonstrated that the theory of mind complex emphasized by Bloom goes through several preparatory stages until it reaches its full articulation. Bloom clearly sees not only the relevance of the theory of mind literature in expaining the details of early vocabulary acquisition, but he is fully aware of the importance of preverbal preferences, as well. We would like to point to one of these constraints that seems to be very important both in early and later stages. We have in mind the notion of GOAL that is shown to be central in early mental representation of action (see e.g. Csibra et al., 1999). GOALS are also of central importance in mental representations underlying language (Jackendoff, 1994), especially the ones underlying spatial language (Landau and Jackendoff, 1993). Some of our data show that this GOAL-directedness of human cognition is one of the easier cognitive templates of human language. In Hungarian, where thereis an obligatory differentiation between GOAL, STATIC, and SOURCE relations, a study analyzing 12.000 utterances in children between 1;5 and 2;5 of the MacWhinney

(1995) corpus showed the following percentages for spatial suffixes: GOAL 80 % STATIC 13 %, and SOURCE 7 % (Pléh, Vinkler, and Kálmán, 1996).

This clear preference for coding GOAL might well be explained by input factors, To examine this, following the model of Landau (1994), artificial spatial suffix and postposition learning situations were created where children between 3 and 6 (n = 238) had to learn the meaning of new spatial expressions (for the method and results see Pléh et al., 1999, Király et al, 2001) in different spatial settings.

Table 3. Learning artificial spatial markers with different forms. Correct binary choice percents

Age	3;6		5;6	
	Goal	Source	Goal	Source
Suffixes	70	52	60	42
Postpositions	64	48	74	29

Table 3 shows that GOAL is easier to learn both in suffixes ($F_{2,92}=8.77$, $p<0.01$) and in postpositions ($F_{2,142}=9.64$, $p<0.01$) and neither the spatial settings (like *diagonal, under* etc.) nor age had a significant effect.

Thus, GOAL as a cognitive template seems to be present in the earliest times, but what is surprising, is that it is still used as a template after primary language acquisition has been well advanced.

Taking into consideration cognitive constraints such as working memory capacity and goal preferences may help to better explain individual differences and neuropsychological phenomenon in language acquisition. How would strong individual differences in vocabulary be possible among Williams syndrome children with an unimpaired theory of mind? And how could autistic children learn language with a serious theory of mind deficit? A possible answer would be that simple cognitive mechanisms speed up or block the process of word acquisition. The limited capacity of working memory supports language learning, works as a "language learning device" (Baddeley et al., 1998), while GOAL as a cognitive bootstrapping helps to unfold the meaning of words.

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