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NAMES, CATEGORIES AND THEORIES

Our research has demonstrated consistent changes in the ways that very young children categorize objects, both in their spontaneous sorting and in their naming and that developments in these two areas are closely and specifically related. The close relations between these two areas of development supports the idea that there are underlying conceptual changes that lead to changes in both language and non-linguistic problem-solving. It is suggested that these conceptual changes may be analogous to theory changes (Gopnik & Meltzoff, 1997).

Sorting and categorization in infants and young children

There are many different techniques that have been used to explore the ways that young children and infants categorize objects. One technique that has been used extensively with preverbal infants is to study their spontaneous manipulation of objects. Early cross-sectional studies suggested that there are significant changes in such behavior at about 18 months. At 12 months infants will pick out all the objects of one sort from a mixed group of objects (Ricciutti, 1965; Starkey, 1981; Sugarman, 1983). However, they do not separate a mixed group of objects into two separate piles, what we have called exhaustive sorting, until they are over 18 months old. In short, there seems to be some ability to classify a limited number of objects early in infancy, but there is also a striking change in this ability at about 18 months of age.

In a longitudinal study (Gopnik & Meltzoff, 1987) we tested 12 children every three weeks for six months. We found a consistent developmental sequence of classification behaviors. Children sorted one type of object into a pile first, and then sequentially touched objects in both categories. Finally, they exhaustively sorted all of the objects into two separate piles. This type of behavior only emerged at around 18 months.

One question that these studies raise is whether children will show the same pattern of spontaneous classification when they are shown a group of objects with within-category differences. In the earlier cross-sectional studies the objects in each category were virtually identical. On the other hand, in the classic "Vygotsky blocks" task, which was long taken as an indicator that young children would not spontaneously classify objects into categories at all, the objects varied and were similar along several different dimen-

sions. Children were expected to pick out all the objects with a single common feature. In these circumstances even three-year-old children tend to group objects "complexively" rather than dividing the groups into categories.

We studied whether and when children began to sort objects with intracategory variation and how this development was related to identical sorting and to other cognitive developments in this period. We tested 32 18-month-old children on categorization tasks, using both identical objects within each category, as in the earlier experiments, and natural objects with intracategory variation. For example, we gave the children a mixed set of four different rings and four different rocks. Children also received means-ends and object-permanence tasks. 18-month-old children sorted both identical and varied objects. This was the first demonstration that children this young could sort objects with intracategory variation. Mandler and Bauer found similarly that children would show systematic patterns of serial touching of objects from different categories (Mandler & Bauer, 1988).

In a more recent unpublished study we extended this work to younger infants. We tested 12- and 15-month-olds with the same stimuli we originally gave to the 18 month olds. The cross-sectional results confirm the earlier longitudinal studies. Twelve and 15 month-olds did sort objects into single categories, but they did not show exhaustive sorting of objects into several categories.

Naming spurt

Another important index of categorization behavior is the use of early names. Are these changes in categorization behavior related to object naming? At least some children show a marked change in their use of names early in the one-word stage. This change has been dubbed "the naming spurt". At around 18 months children frequently begin to acquire many new names and begin to name everything in sight, and use words like "whatsat" to request names for new objects.

There has been a wide range of theoretical interpretations of the naming spurt. Some investigators have related it to a difference between "referential" and "expressive" learning styles (Nelson, 1975). Other investigators have suggested that the spurt is essentially a linguistic phenomenon, that it reflects a new level of formal linguistic ability (McShane, 1980). Markman (1987) suggests that the naming spurt might result from the activation of a constraint. Others have suggested that the naming spurt might be related to phonological reorganization. Still others have suggested that it is related to a general cognitive reorganization (Nelson & Lucariello, 1985).

We have proposed that the naming spurt reflects a specific conceptual change that involves the categorization of objects, rather than reflecting purely the development of some more general formal linguistic or cognitive ability. In particular, we hypothesized that the naming spurt might be closely related to changes in spontaneous classification. We proposed that this relation between language and cognition is quite specific. Moreover, it might be bi-directional in that children's attention to naming may itself influence their ability to categorize. This proposal was based on our earlier findings of several other similar specific relations between semantic and cognitive development in this period (Gopnik & Meltzoff, 1984).

In the longitudinal study of classification I described above (Gopnik & Meltzoff, 1987), we also recorded when the children developed the first signs of a naming spurt, an

event which we, like others, operationalized as the first session in which more than ten new names appeared. We found close relations between the development of exhaustive sorting and the development of a naming spurt. These two developments appeared in close concert and there was a high correlation, .78, between the age at which children developed a naming spurt and the age at which they developed two-category classification abilities.

These findings are even more striking when we compare them to the relation between the naming spurt and means-ends ability. There was a much larger gap between the naming spurt and the development of insight, and no correlation, -.017, between the ages of the two developments. This suggests that the relation between naming and classification does not simply reflect some broader relationship between cognitive and linguistic ability at about 18 months of age. Instead, it appears to involve a close and specific link between a particular cognitive domain, categorization, and a related linguistic domain, naming.

In the cross-sectional studies, children's parents received a checklist of early names taken from the MacArthur Communicative Development Inventory, a checklist of early words which has been shown to be a reliable indicator of language development. They were also asked whether their child had had a naming spurt. For both types of objects, identical objects and those with intracategory variation, children who exhaustively sorted the objects had on average a greater number of reported names than those who did not, and their parents were more likely to report that they had had a naming spurt (Gopnik & Meltzoff, 1992). Recently, these findings have been replicated and extended by Mervis (Mervis & Bertrand, 1993; Mervis et al. 1992), who found that both the naming spurt and exhaustive sorting were also specifically related to the ability to learn new object names quickly. Moreover, they found this relation both in normally developing children and in children with Down syndrome.

This finding supports the idea that there is some common conceptual change that underlies the developments in both areas. The individual changes in cognitive development or language development might, by themselves, be due to many factors. Perhaps children categorize better because their manipulative skills improve or produce more names because their phonology improves. However, when both these developments are closely linked and emerge within a few weeks of each other, these explanations seem less likely. Why would changes in manipulative skill lead to the production of a new word or changes in phonology lead children to sort objects in a new way? The two types of behavior seem to be linked by their conceptual content rather than by more superficial features of the tasks.

Cross-linguistic studies

The close relation between naming and categorization behavior in these children also suggests that there may be a bi-directional interaction between language and cognition. That is, it is possible that paying attention to object names actually reshapes children's understanding of object categories. One way to test this idea is to study children who have different patterns of linguistic input. In collaboration with Prof. Soonja Choi at San Diego State University I investigated the relations between categorization and naming in Korean-speakers (Gopnik, Choi & Baumberger, 1996; Gopnik & Meltzoff, 1997). English has relatively simple verb morphology, and nouns are generally obligatory in English sentences. In contrast, Korean and Japanese, languages with similar structures, have a rich verb morphology, and can often omit nouns. Given our earlier findings with English speak-

ers, we therefore predicted that Korean speakers would be advanced in their understanding of actions, concepts encoded by verbs, and delayed in their understanding of object categories, concepts encoded by nouns. Such a finding would confirm the claim that specific developments in naming and categorization are closely linked, and that underlying conceptual changes are responsible for both types of developments.

In an extensive longitudinal study (Gopnik, Choi & Baumberger, 1996), we collected detailed data about 11 Korean-speaking children's cognitive and linguistic development over the course of a year. In each testing session children received the cognitive tasks that we had used in our earlier studies of English speakers. Mothers also received an extensive diary-like language questionnaire and interview specifically designed for Korean. We also recorded the children's spontaneous language. There were significant differences between Korean and English speakers' language development. The English speakers used a preponderance of nouns and very few verbs, while the Korean speakers used about equal numbers of nouns and verbs.

Moreover, there was also a significant parallel difference between the Korean and English speakers' performance on the categorization tasks. The Korean speakers were significantly delayed on this measure compared to the English speakers. The opposite pattern held for the development of means-ends abilities and words that encode success and failure, verbs in Korean. Korean-speaking children were significantly advanced in both these areas of development compared to the English speakers.

In a second cross-sectional study we again compared the cognitive performance of 18 Korean-speaking children and 30 English speakers, all 18 months old (Gopnik, Choi & Baumberger, 1996). The results confirmed those in the longitudinal studies. The Korean speakers were significantly worse on categorization tasks than the English speakers, and significantly better on means-ends tasks. Just as naming and categorization development were linked in English speakers, they also appeared to be linked when we compared the two languages. Moreover, these results also suggest that linguistic experience may itself influence conceptual change.

Classification, naming, and action understanding are based on naive theories. These theories influence each another and change analogically to scientific theories.

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