

Operating Principles and Personal Theories:
An Outline of Their Roles In Early Lexical Development

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Very young children, like adults, form object categories on the basis of similarity among exemplars. But this statement is simplistic: The notion that categories are formed on the basis of similarity is not constrained adequately (Murphy & Medin, 1985). For example, consider the triplet horse, zebra, barber pole. Almost everyone would agree that the horse and the zebra were the most similar pair. In this case, similarity is being defined according to general form attributes or biological attributes. However, if the attribute "striped" were given sufficient weight, then the zebra and the barber pole would be the most similar pair. The type of similarity that provides the basis for category assignments must be specified. Murphy and Medin (1985) have argued that adults use personal theories to determine the types of similarity that will be noticed. Personal theories generally refer to informal theories or beliefs about the world that a person can state explicitly, or can answer questions about. These theories may be general, or may be restricted to specific domains. In addition to personal theories, both children and adults use operating principles or, in Slobin's (1973) words, basic self-instructions, to determine which types of similarity will be noticed. These operating principles usually are implicit and apply generally, rather than to particular domains. Infants and very young children are able to use operating principles prior to personal theories, and the use of operating principles continues throughout the lifespan.

In this paper, I describe several operating principles that I believe are used during late infancy and early childhood. I also discuss two of the earliest personal theories used by young children. I consider the effects these operating principles and personal theories have on early conceptual and lexical development and on the evolution of children's initial categories to conform to the adult standard. The proposed operating principles and personal theories are consistent with the results of a longitudinal study of early lexical development of normally developing children and children who have Down syndrome (Mervis, 1984, in press a, in press b) and the results of a diary study of my son Ari's early lexical development (Mervis, in press a).

ACQUISITION OF THE FORM-FUNCTION PRINCIPLE

By age 7 months, normally developing infants have acquired several principles that are critical for early conceptual development. First: Categories generally are concerned with whole objects (cf. Hofsten & Spelke, 1985). Second: Categories should be formed, and category assignment decisions made, based on similarity of attributes (e.g., Cohen & Younger, 1983). Third: The most important static attributes are those relevant to determining form (Olson & Strauss, 1978).

These infants treat attributes of the type generally used in categorization decisions as independent of one another (Cohen & Younger, 1983). By 10 months (the beginning of stage 5 of the sensorimotor period), infants have begun to notice correlations among attributes of the type generally used in categorization decisions. Furthermore, these infants weight correlated attributes more heavily than attributes that occur equally frequently within the category but are not correlated with one another (Cohen

& Younger, 1983), suggesting that the infants are sensitive to the importance of correlations for categorization. Infants notice both static (form) and dynamic (function, action) attributes, and begin to realize that form attributes usually have correlated function attributes, and that function attributes usually have correlated form attributes (e.g., Piaget, 1954). Thus, by age 10 months, infants have acquired a crucial principle concerning categorization, the form-function principle. This principle is: The form and function of objects generally are correlated. This attribute correlation should be used as the basis for categorization. Objects that have similar clusters of form attributes and correlated function attributes should be assigned to the same category. A corollary to this principle is that correlated attributes are more important in determining conceptual coherence than are equally frequent but uncorrelated attributes. However, as Murphy and Medin (1985) have pointed out, the correlated attributes principle, while providing more constraint on categorization than a simple similarity principle, still is inadequate. Additional principles are necessary to determine which correlations actually are noticed.

Form-function correlations are most obvious for basic level categories (Rosch, Mervis, Gray, Johnson, & Boyes-Braem, 1976). Not surprisingly, therefore, children's first categories are basic level categories (e.g., Mervis, 1983; Rosch, et al., 1976). Adult categories, particularly basic level ones, also tend to be formed based on such correlations. However, children's initial basic level categories often will not correspond to the adult-basic level category labeled by the same word. Such differences are to be expected; only the principles governing the determination of basic level categories are universal (e.g., Dougherty, 1978; Mervis, 1984; Rosch, et al., 1976). An object generally affords more than one set of form-function correlations. Therefore, everyone will not necessarily attend to the same correlations for a given object. The actual categories formed on the basis of the form-function principle will vary because different groups notice or emphasize different attributes of the same object as a function of different experiences or different degrees of expertise. Very young children often do not share adults' knowledge of culturally appropriate functions of objects and the correlated form attributes, leading children to de-emphasize attributes of an object that are important from an adult perspective (e.g., Mervis, 1981, 1984, in press a; see Carey, 1982, for a similar position concerning verb concepts). For example, a very young child does not have a concept of money or of saving money. Therefore, when confronted with a spherical bank, the child should ignore the slot and the keyhole. At the same time, children may notice a function and its correlated form attributes for that object that adults ignore. In such cases, children would emphasize attributes of an object that are unimportant to adults. To continue the spherical bank example, the child would notice that the object rolls and is round. Tversky and Hemenway (1984) have suggested that children often ignore small attributes that have functional significance for an adult, in favor of large attributes of the same object that afford an alternative function. In the spherical bank example, the child would ignore the slot and keyhole in favor of the round shape. (Note that different labeling practices of mothers when talking to young children rather than to adults are not responsible for these category differences; see Mervis, 1984, in press a, in press b.)

ACQUISITION OF THE ADDITIONAL CATEGORY PRINCIPLE

Children's categories that differ from the corresponding adult categories eventually must evolve to conform to the adult standard. For very young children, the first step in this process generally is the formation of a new category that includes certain members of one of the child's already-existing categories. The principle that guides this process is as follows: Assign a previously assigned object to an additional, newly formed category only if you are given concrete evidence of a new form-function attribute correlation that differs from the one on which you based your original assignment. (This new form-function correlation serves as the basis for the newly-formed category.) This principle is derived from the original form-function principle. Note that after application of this principle, the object is included in two (or more) categories; it remains a member of its old category, as well as being added to the new category.

Indications of the presence of a new correlation can take a number of forms; as part of all of these, an adult generally provides the adult-appropriate name for the object. As one possibility, the important attribute might be indicated by the child. The adult would be likely to respond by acknowledging the attribute that the child had indicated and then labeling the object with its adult-basic name. For example, if the child pointed out the wick of a round candle to the mother, she probably would respond by commenting on the wick and its function and then labeling the object, "candle."

Alternatively, an adult may point out the important attributes. Regardless of who identifies the relevant attributes, the most effective methods of introduction of the adult-basic name involve a clear indication of the new form-function correlation on which the new category should be based. Among the several methods used by adults, the most explicit indication of this correlation occurs when a concrete illustration of relevant form attributes and the correlated function attributes is provided, accompanied by a verbal description. For example, the adult might run a finger along the slot of a round bank, drop in a coin, and tell the child that this is a slot into which you put money. Use of concrete illustration without a verbal description or verbal description without concrete illustration is less effective, because the correlation is not made as explicit. The concrete illustration method is more effective than the verbal description method for very young children, because these children are more oriented to objects and action than to language. Finally, use of the adult-basic name alone is extremely unlikely to be effective. The metacognition necessary to realize that adult use of a new label implies the existence of a new form-function correlation is relatively sophisticated.

ACQUISITION OF THE EXPERT PRINCIPLE

At least two other important principles are acquired during the period of early lexical development: the expert principle and the origins principle. Acquisition of these principles occurs subsequent to acquisition of the principles already discussed. The new principles lead to changes in the perception of similarity. In this section, I consider the expert principle. The origins principle is considered in the following section.

For at least several months after the child has acquired the form-function principle, the role of purely linguistic input in categorization is relatively minor. However, once the child acquires the metacognition necessary to realize that adult use of a label for an object implies that the object is a member of the labeled category, the role of linguistic input can increase dramatically. This metacognition is based on acquisition of the

expert principle: There exist people (experts) who know more about categorization (or some types of categories) than you do. When these people apply a name to an object, they probably are correct. The expert principle requires acceptance of another person's authority on categorization issues, even when the child does not understand the basis for the other person's category assignment.

As noted previously, prior to acquisition of the expert principle, the child's categorization scheme is not influenced by adult use of adult-basic labels by themselves, without a concrete illustration or verbal description. Impressively, even after the child becomes aware that adults apply a different name to a given object (assign that object to a different category), the child is willing to let the two category assignments co-exist.

With regard to the addition of new categories, the expert principle takes two forms. The first is: Form a new category, and assign the relevant object(s) to it, if an expert labels the object with a word not included in your lexicon. The second is: Add another category assignment for a previously assigned object if an expert labels the object with a name different from the name of the category(ies) to which you had assigned the object. Both versions of this principle entail the child deciding to search for correlated attributes to serve as a category basis, just because an adult used a new label for a particular object. (It is possible for the child simply to learn the new name in reference to the object labeled, without searching for relevant attributes. In this case, however, the child will not generalize the name; it will serve essentially as a proper name for a particular object.)

Children who have acquired the expert principle, like adults, do not always accept the expert opinion (see Neisser, in press). However, in contrast to the pre-expert principle child, who is comfortable ignoring a contradictory adult label or allowing it to exist side by side with his or her own label, the child who acknowledges the expert principle cannot simply ignore contradictory input. The latter child will respond to the adult when a difference in labels occurs.

Once the child has acquired the two forms of the expert principle just described, two other forms should follow. Both involve deletion of objects from their assigned categories, ultimately yielding mutually exclusive basic level categories (Tversky and Hemenway's, 1984, mutual exclusivity of basic level categories principle). (More generally, the two forms should yield mutually exclusive coordinate categories.) *The first is: Delete an object from its previously assigned category if you label the object with that name and an expert rejects your label. The second is: Delete an object from its previously assigned category if an expert labels the object with a name different from the one you would have applied, and you have reason to believe that the two names are coordinate.*

The expert principle provides the child with a major improvement in his or her ability to acquire new categories rapidly, based on very little input. It is important to note, however, that the new categories the child forms on the basis of the expert principle are still based on the form-function principle as well. The important contribution of the expert principle is that, based on minimal input, it provides the child with an indication that a new category must be formed. The child still must search for a new form-function attribute correlation, as a basis for generalization. If the child cannot find such a correlation, then he or she will be unable to form a new category that includes more than the object to which the adult applied the new label.

ACQUISITION OF THE ORIGINS PRINCIPLE

The origins principle states that: Membership in a biological category is determined by lineage (ancestry, origins); an animal or plant belongs to the same category as its parents, and the progeny of the animal or plant also belong to the same category (e.g., Kell, In press). Acquisition of the origins principle requires acceptance of the expert principle (see Mervis, 1986).

Prior to acquisition of the origins principle, toddlers focus on observable attributes and categorize accordingly, based on the form-function principle. The available origins information (generally in the form of adjacency, as when an adult animal is depicted next to its offspring) is ignored. As Neisser (In press) has pointed out, such a focus usually will yield the same category scheme as a more sophisticated approach based on the origins principle. Sometimes, however, the two approaches yield different category assignments. For example, baby waterbirds generally are shaped more like ducks than like other types of waterbirds. In this case, the pre-origins principle child will categorize all baby waterbirds as ducks, even when he or she correctly categorizes an adjacent adult waterbird. After the child begins to acquire the origins principle, baby animals will be categorized according to parental species, whenever parental species is obvious. Categorization of juveniles will be more accurate when an adult category member is present than when the adult is absent. Prior to acquisition of the origins principle, categorization of juveniles will not vary as a function of the presence or absence of adult category members.

As is clear from Keil's (e.g., In press) research, development of the origins principle continues even during the grade school years. However, acquisition clearly begins during early childhood. This acquisition represents the earliest evidence of deviation from the form-function principle as a basis for categorization decisions. Eventually, for experts, categorization according to the origins principle will again conform to the form-function principle, but for a different set of correlations. This time, the correlations will involve genetics.

SUMMARY

In this paper, I have considered several operating principles as well as two personal theories that I believe are used during late infancy and early childhood. By age 10 months, infants have acquired the major categorization principle used across the lifespan: the form-function principle. However, infants often do not apply this principle to the same correlations as adults. Therefore, the two groups sometimes assign the same object to different categories. Category evolution, which must take place in order for the child's categories eventually to correspond to the adult standard, at first is based on the additional category assignment principle, which requires the adult to make a new form-function correlation obvious to the child. Eventually, category evolution is greatly influenced by the expert principle, which also subsumes the mutual exclusivity of basic level categories principle. The origins principle, which is based in part on the expert principle, allows the child to go beyond the form-function principle in determining the category assignments of juvenile category members. These principles clearly are important for the development of young children's categorization schemes. However, consideration of the role of operating principles and personal theories in category development has just begun. Further research and theorizing to determine additional principles and theories and their roles in category development and evolution are essential.

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