Feature taxonomy: What type of features do children associate with categories and how do they fare in predicting category judgments?

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ABSTRACT

The present study investigates category intension in school-aged children and adults at two different levels of abstraction (i.e., superordinate and basic level) for two category types (i.e., artefacts and natural kinds). We addressed two critical questions: what kind of features do children and adults generate to define semantic categories and which features predict category membership judgment best at each abstraction level? Overall, participants generated relatively more entity features for natural kinds categories, compared to artefact categories, as well as for basic level categories, compared to superordinate categories. Furthermore, the results showed that older children and adults generated relatively more entity features than younger children. Finally, situation features play the most important role in the prediction of category judgments at both levels of abstraction. Theoretical implications and comparable results from previous studies are described in detail.

1. Introduction

The world is a complex place that consists of an infinite number of different stimuli. Humans try to overcome the problems posed by this diversity by cutting up the environment into a classification structure, a process called categorization. In order to categorize, people need to focus on attributes or features related to particular concepts so that they can simplify the different stimuli into these concepts. Using these features people can decide whether an object belongs to a certain concept or not (e.g., Malt & Johnson, 1992; Vanoverberghe & Storms, 2003). However, the quality of potential features may differ. Some attributes are better suited to define category membership than others. Furthermore, the importance of a feature in defining category membership can differ across age groups (e.g., Mervis, 1987).

Over the years, several methodologies have been used to investigate what kind of features play important roles in delineating categories, both in studies with adult participants and in developmental studies. The techniques varied from studying dictionary definitions (Farah & McClelland, 1991), over providing featural descriptions of to-be-categorized exemplars (Gelman, 1988; Hampton, Storms, Simmons, & Heussen, 2009; Keil & Batterman, 1984), to feature generation studies (Vanoverberghe & Storms, 2003). First, we will provide an overview of these studies' main findings, from which we will then derive the specific predictions that are tested in the present study.

1.1. Studies with adult participants

Two general conclusions can be drawn from the array of studies using adult participants. First, perceptual features (e.g., "has wings") tend to be more important in decisions about category endorsement for natural kind categories, while functional features (e.g., "used to work with") are more important to decide on membership in artefact categories (Barr & Caplan, 1987; Barton & Komatsu, 1989; Farah & McClelland, 1991; Medin & Ortony, 1989; Rips, 1989; Rosch, Mervis, Gray, Johnson, & Boyes-Braem, 1976; Tversky & Hemenway, 1984).[1] Contrary to this general view, however, Malt and Johnson (1992) found that membership decisions for artefacts were influenced more by perceptual features than by functional information, leading them to claim that functional features alone are not sufficient to determine membership in artefact categories.

Second, level of abstraction also plays an important role in determining the type of features that define category membership. Rosch et al. (1976) found that functional features were generated most frequently for superordinate categories, while perceptual features were generated most frequently at the basic level. The latter finding was taken to mean that the basic level forms the most abstract level at which an object can be perceptually identified while at the superordinate level differences in physical appearance are not as salient as at the basic level. Rosch et al.'s (1976) claims were partly supported by the findings

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  [1] Note, however, that the distinction between natural kinds and artefacts is not a strict dichotomy, since there are borderline cases, such as cultivated fruits, bred animals, and mineral compounds.

from a feature generation study from Vanoverberghe and Storms (2003), who found that perceptual features are more important for the basic level, while for the superordinate level, perceptual and functional features are equally important.

1.2. Developmental studies

Many studies have been conducted to investigate the developmental shift of category representations based on features. We will highlight some key findings that served as building blocks for the present study. In one of the earliest studies of this kind Mervis and Crisafi (1982) asked children (aged 2- to 5-year-olds) to divide pictured stimuli into categories defined at different hierarchical levels. They found that the acquisition of feature types is influenced by the order in which category levels are acquired. Since the basic level is acquired first, children start predominantly with perceptual features, but as they get older they rely more on functional features, which become more important for the superordinate level.

Using a different paradigm, Keil and Batterman (1984) investigated children's early category representations by focusing on characteristic and defining features. They presented school-aged children (kindergartens, second graders, and fourth graders) with two kinds of stories about potential exemplars of a category (e.g., hats, churches). In one kind of story, exemplars were described as being characterized by correct defining features, which were mostly conceptual in nature, but they lacked important characteristic features, which were mostly perceptual. The second sort of stories consisted of the opposite pattern. Keil and Batterman asked children whether the described instance was a true member of the category. The results showed that there is a shift across age groups from using characteristic, mostly perceptual features to defining, mostly non-perceptual features, and children who are in the transitional phase tend to use both types of features. Thus, the shift might denote an increasing ability to understand concepts and to attend to attributes that are not directly apparent.

Keeping basically the same research paradigm, Keil (1989) followed up on this finding by explicitly investigating the shift in different types of categories, namely natural kinds and artefacts. In one of his studies, he investigated the transformation of objects' identities based on changes in the type of applying features. Keil told school-aged children (5 to 11 years) stories in which certain changes were introduced in natural kind and artefact objects. He found that kindergartners relied on appearance more than on function for both artefacts and natural kinds. Keil argued that, since younger children have shallower theories, they tend to rely more on perceptual (a-theoretical) similarities, while older children rely more on function and less on appearance, especially for artefacts.

Gelman (1988), using an inductive interference task, also investigated the role of different types of features in preschoolers and second graders. She taught the children a new fact (i.e., a new feature) about a category exemplar and checked whether they generalized it to other category members. Second graders tended to find the functional features more generalizable than perceptual features for artefacts, while for natural kinds, the opposite pattern was found. For the preschoolers, this distinction was less pronounced than in second graders.

2. Current study

Summarizing, various developmental studies suggest that young children seem to focus on perceptual features. As they get older, they evolve towards a focus on functional features, but this is more pronounced for artefacts. However, even though all of the described papers tried to find out which (kind of) features are important in the categorization process of children, none of the studies addressed the question directly by asking children to *generate* relevant features. The present study tries to fill this gap by having children of different age

groups, as well as adults, sum up features that are important to determine membership for a set of natural kinds and artefacts. To the best of our knowledge, this is the first study that allows a systematic comparison between groups of different ages in terms of the kind of features (perceptual versus functional) they *generate*.

We also wanted to investigate which features *predict* category membership judgment best. Furthermore, we examined these two questions using different kinds of categories: natural kinds (e.g., fruit and berries) and artefacts (e.g., vehicles, bicycles, etc.); as well as categories defined at different levels of abstraction: superordinate (e.g., clothes, musical instruments, etc.) and basic categories (e.g., trousers, guitars, etc.). For these purposes, we gathered feature generation data and category judgment scores from different age groups. Generated features were classified into the four basic categories of Wu and Barsalou's (2009) coding scheme: taxonomic, introspective, entity, and situation features. Taxonomic features refer to the position of the concept in the category taxonomy and includes synonyms, superordinate, subordinate, and coordinate categories as well as specific instances of the concept (e.g., car - automobile; cat - animal). Introspective features refer to the mental state evoked by the concept, such as affects and emotions, evaluations, etc. (e.g., apples - I like; smashed car - anger). Entity features are features of a concrete entity, such as external surface features, internal surface features, and external and internal components (e.g., apple - red; watermelon - juicy). Finally, situation features refer to situations in which the concept functions in an event with one or more participants, at some place and time (e.g., shirt - worn; car - transport). Crucial for the purpose of our study is that, for the concrete concepts that we used as stimuli, perceptual features are classified as entity features and functional features are coded as situation features.[2]

Regarding the type of features people generate, three hypotheses were derived from the described literature. First, we expect predominantly entity features for natural kinds, while for artefact categories, we expect a more even mix of situation and entity features (Farah & McClelland, 1991; Vanoverberghe & Storms, 2003). Second, based on the findings from Rosch et al. (1976) and Vanoverberghe and Storms (2003), entity features are expected to be generated more frequently for the basic level categories, whereas situation features are expected to be generated more frequently for the superordinate level categories. Third, in line with Keil and Batterman (1984) and Keil (1989), we predict that the youngest children start off mainly with entity features and as children get older, they will rely more on situation features. However, the latter might depend on the category type and the level of abstraction. That is, developmental studies suggest that older children (and adults) will still generate (mainly) entity features for basic level categories (Mandler, 2000; Mervis & Crisafi, 1982) and natural kinds categories (Gelman, 1988; Keil, 1989).

To examine the value of the entity and situation features in predicting categorization decisions we used the family resemblance model from Rosch and Mervis (1975), which has been shown to relate strongly to category related variables (e.g., Ameel, Malt, & Storms, 2008; Verheyen, De Deyne, Dry, & Storms, 2011). The general idea is that objects are more likely to be considered category members if they possess the most important features for that category. Put differently, the higher an objects' family resemblance score, the higher the likelihood of belonging to the category in question. So besides a feature generation and category judgment task, we also obtained feature applicability judgments in order to calculate family resemblance scores (see the Results section for more details). The critical question is whether the entity-based family resemblance scores predict category judgments better or worse than the situation-based family resemblance scores. More specifically, category type, level of abstraction, and age

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[2] Although Wu and Barsalou's (2009) coding scheme contains further subdivisions, we only use the four basic classifications here.