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Object Naming and Later Lexical Development

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Abstract

Learning to name objects is no sinecure. Children's initial word use often will not correspond to the adult use of the same word. We suggest that semantic development may continue well past the early years of language acquisition, even for names for concrete objects. We studied evolution of the use of common nouns taking place during later lexical development. Children aged 5, 8, 10, 12 and 14 years and adults named common household objects and their naming patterns were compared. The results showed a gradual convergence to the adult categories over age. Rather than adding new words to their vocabulary, children reorganize the existing categories. Features collected from adults were used to predict the naming patterns of the different age groups. In line with Mervis (1987), children gradually learn to attend to the right features and gradually assign the appropriate weight to these features. However, the features do not tell the full story. Each language contains idiosyncratic mappings between objects and words that must be mastered through experience. Implications for theories of later lexical development are discussed.

Introduction

Children learning the words of a first language must isolate word forms, identify potential meanings, and assign these meanings to the newly isolated words (Clark, 1995). It appears that children need only minimal exposure to a new form before assigning some meaning to it. As soon as a possible meaning is assigned, the word is ready for use. This phenomenon, called *fast mapping*, allows children to add words to their vocabulary at a rapid rate during the first years of language learning (Carey, 1978). Fast mapping, however, captures only a fraction of the meaning adults attach to a word, and many studies have been devoted to understanding how children refine the meanings of words during the early years of language learning.

A much smaller literature demonstrates that semantic development may continue well past the early years of language acquisition for certain word classes. For example, the meanings of orientational terms (*top*, *bottom*, *front* and *back*) are not fully mastered until the age of 5 (Clark, 1980), and several studies have shown learning periods for verb meanings extending to age 8 or 9 (e.g., Gropen, Pinker,

Hollander & Goldberg, 1991; Gentner, 1978). In contrast, common nouns naming familiar, concrete objects have widely been assumed to be unproblematic for children. Gentner (1978, 2005) has suggested that acquisition of common nouns is a faster process than verb acquisition because common nouns refer to entities easily segregated from their context, while verbs convey relationships among entities. This suggestion is compatible with Rosch's (1975) proposal that common nouns capture sets of things sharing many inter-correlated properties, and with the assumption in the second-language learning literature (De Groot, 1993; Kroll, 1993) that the meanings of common nouns will tend to be closely equivalent across languages.

But evidence has begun to accumulate suggesting that the case of common nouns is more complex than previously thought. Malt, Sloman, Gennari, Shi and Wang (1999) found substantial variability across languages in the sets of objects picked out by names for common household containers, even though the perception of similarity by speakers of the languages was much the same. This result indicates that the linguistic categories of a language are not strictly formed around similarity-based clusters (see also Ameel, Storms, Malt, & Sloman, 2005). Malt and Sloman (2003) found that second-language learners retained discrepancies from native speakers in their use of English nouns for common containers and other housewares even after more than 13 years of immersion in an English-language environment. These discrepancies appear to reflect non-equivalences of meaning between languages and the resultant complexity of the learning task. Andersen (1975) asked English-speaking children aged 3, 6, 9 and 12 to name ordinary drinking vessels and found that it was not until age 12 that children's use of terms such as 'cup' and 'glass' fully converged on adult usage. Thus learning to use common nouns like an adult speaker may present challenges not yet fully appreciated.

The questions we address in this paper are: First, is the learning trajectory for common nouns referring to familiar objects more extended than generally assumed? Second, what is the nature of the learning that must take place? And finally, what pushes the child toward greater convergence with the adult use after she has established a working grasp of a word?

Two studies were conducted to answer these questions. In the first, we collected naming data for a large set of common household containers from children aged 5 to 14 and from adults. We evaluated whether there was substantial evolution in the use of the terms for this domain across these ages, well past the early years of language acquisition. We also evaluated whether observed changes could be accounted for by the entry of new words into the vocabulary. In the second study, we gathered features from adults for the most important linguistic categories in the naming data and used them to evaluate several hypotheses about how the knowledge associated with the words changes over time.

Study 1

Andersen's (1975) study of children naming drinking vessels used a relatively small stimulus set and informal analyses. We collected data for a much larger stimulus set in order to replicate and extend her finding and allow for more detailed analyses.

Method

Materials. Seventy-three pictures of household storage containers, taken from Ameel et al. (2005), were used. The objects were selected to be likely to receive the name 'bottle' or 'jar' in American English or else to share one or more salient properties with bottles and jars. Objects were photographed in color against a neutral background with a constant camera distance to preserve relative size.

Participants. A total of 114 native speakers of Dutch of six different ages in the Leuven, Belgium region performed the naming task: 19 5-year-olds, 25 8-year-olds, 25 10-year-olds, 25 12-year-olds and 20 14-year-olds. The naming data of 32 adults were taken from Ameel et al. (2005). Participants used Dutch almost exclusively in their daily lives although some had some knowledge of another language.

Procedure. The children looked through all the pictures to familiarize themselves with the variety of objects and then named each one. Following Malt et al. (1999) and Ameel et al. (2005), they were asked to give whatever name seemed the best or most natural and were told that they could give a single-word name or a name with more than one word. The instructions emphasized naming the object itself and not what it contained. Order of presentation was random. The experiment was conducted in Dutch.

Results and Discussion

Comparison of naming patterns across ages. We tallied the frequency of each noun produced for each object separately by age group. Only the head noun of the response was considered. Diminutive markers and additional adjectives were disregarded. The first analysis is restricted to the dominant name for each object; i.e. its most frequently produced name. Table 1 contains, for each age group, all names that emerged as dominant for at least one object, along

with the proportion of objects for which each name was dominant.

The table shows that considerable semantic development took place between 5 and 14 years. The naming proportions for the children gradually converged to the corresponding proportions for the adults. The set of objects called 'fles' started off very broad and gradually narrowed from 5-year-

Table 1: Linguistic categories for the different age groups.¹

5-year-olds	proportion of objects	8-year-olds	proportion of objects	10-year-olds	proportion of objects	12-year-olds	proportion of objects	14-year-olds	proportion of objects	adults	proportion of objects
fles	0,63	fles	0,47	fles	0,41	fles	0,38	fles	0,36	fles	0,34
pot	0,23	pot	0,29	pot	0,26	pot	0,25	bus	0,19	bus	0,22
doos	0,10	doos	0,10	brik	0,07	bus	0,11	pot	0,18	pot	0,18
blik	0,01	blik	0,03	bus	0,07	brik	0,07	doos	0,08	brik	0,05
fles/doos	0,01	bus	0,03	doos	0,05	doos	0,05	brik	0,05	doos	0,05
mand	0,01	fles/pot	0,03	fles/pot	0,04	tube	0,05	blik	0,03	tube	0,05
		tube	0,03	blik	0,03	blik	0,03	fles/bus	0,03	blik	0,03
		brik	0,01	doos/pot	0,01	fles/bus	0,03	tube	0,03	mand	0,01
		fles/bus	0,01	fles/doos	0,01	mand	0,01	fles/roller	0,01	molen	0,01
		mand	0,01	mand	0,01	pot/vat	0,01	mand	0,01	roller	0,01
		tube	0,01	tube	0,01			pot/doos	0,01	stick	0,01
		tube/fles	0,01					vat	0,01	vat	0,01

olds to adults. The same pattern was found for 'pot' and 'doos'. For 'bus', 'brik' and 'tube', the opposite pattern occurred: these names were not used by the youngest children, but from 8 years onward the category broadened over age².

Quantitative evidence for the gradual shift to the adult naming pattern was found in the name distributions. The name distribution for an object is a vector of numbers indicating, for each name produced to the entire stimulus set, the number of participants who gave the name for that particular object. For instance, a given object's vector might show that 15 participants called it 'fles,' 4 called it 'pot,' and none called it by any other name. To compare the naming patterns of the different age groups, we first computed the similarity of each object's name distribution to every other object's name distribution within each age group by correlating the vectors for each pair. The resulting correlation values reflect the extent to which each pair of objects was named similarly by participants of the same age group. We then correlated the 2628 name similarity values for one age group with the corresponding values for another age group.

¹ When 2 names were generated equally frequently, both names are listed, e.g., 'fles/pot'.

² Translating the Dutch names into English using dictionary definitions may not give a very good indication of what these words mean. However, naming data of American English speakers may be more informative. In a different study, we gathered naming data of American English speakers. Objects named 'fles' in Dutch were mostly called 'bottle' in English, objects called 'bus' mainly received the name 'bottle' or 'can' in English, objects called 'pot' were mainly 'container' or 'jar' in English, objects called 'doos' or 'brik' were 'box' in English and the 'tube' objects were also 'tube' in English.

These correlations indicate in a single value the extent to which two age groups had similar naming patterns.

The bottom line of Table 2 shows that the correlations with the adult naming pattern increased gradually from 5-year-olds to 14-year-olds (Spearman rank correlation $\rho = 1, p < .0001$). The correlations between each pair of age groups also show a gradual increase as ages come closer to each other (e.g., 14-year-olds agree better with 12-year-olds than they do with 10-year-olds). The only exception is the correlation between 5-year-olds and 14-year-olds, which is significantly higher than the correlation between 5-year-olds and 12-year-olds ($p < .05$).

Table 2. Correlations between the name distribution similarities for each pair of age groups.

age	5	8	10	12	14
8	0,71				
10	0,63	0,86			
12	0,55	0,83	0,84		
14	0,64	0,79	0,79	0,85	
adults	0,51	0,68	0,73	0,82	0,87

Does vocabulary growth account for the changes? The data provide some information about what drives children to continue to refine their use of these words over a period of 9 or more years. Clark (1995) has suggested that the entry of new words into a child's vocabulary triggers refinement in later lexical development. Table 1 shows, however, that there was only a small increase in total vocabulary for these objects across ages. Adults' main names, 'fles', 'bus' and 'pot', were used by all the other age groups, except for 'bus' by 5-year-olds. The next most common adult names, 'doos', 'brik' and 'tube', with a frequency of 4 each, were also used by the other age groups with the exception of 'brik' and 'tube' for the 5-year-olds. Four other names that entered the vocabularies very late ('vat' and 'roller' at 14, and 'molen' and 'stick,' first used by adults) were applied to only a total of 4 objects. These additions to vocabulary can at best explain only part of the refinements in use of the main names. For instance, 8 year olds used 'bus' for only 2 objects whereas adults used 'bus' for 16. A finer partitioning of semantic space due to a larger vocabulary would not predict this growth in category size. Rather, there seems to be reorganization of the existing categories. In this age range, observing discrepancies from adult usage or explicit negative feedback from adults may contribute to semantic development above and beyond the effect of new words entering the semantic field per se.

In sum, this study demonstrates continued semantic development well into adolescence for nouns labeling familiar household objects -- development that can only be attributed in part to vocabulary growth.

Study 2

Given confirmation that semantic development occurs across an extended period of time for the common nouns studied, we now ask what the nature is of the learning that must take

place. Evidence on this issue for early semantic development has mainly come from descriptive diary studies (e.g., Mervis, 1987; Clark, 1995). In addressing this issue for later development, we provide a larger-scale experiment that allows us to compare predictions of different theories quantitatively.

Several theories of early semantic development have proposed that the differences between child and adult word use arise through differences in featural knowledge. The Semantic Feature Hypothesis (Clark, 1973) suggests that the meaning of a word is initially identified with only a few semantic features. By adding more features, the child gradually learns the full meaning of a word. Consequently, child linguistic categories will tend to be larger than adult categories, since only one or two features are used to pick out referents instead of the whole set of adult features. In line with the Semantic Feature Hypothesis, Andersen (1975) found that young children over-extended the word 'cup', while somewhat older children focused on certain perceptual properties, resulting in more subcategories. The oldest children combined perceptual and functional properties in determining the word's extension.

However, sometimes a child's categories are narrower than the corresponding adult's categories rather than broader. For example, a child's use of the word 'chair' may not include beanbag chairs (Mervis, 1987). Nelson (1974) proposed that the child attends to more features than adults do, rather than fewer, resulting in under-extended categories. Over time, children gradually give up irrelevant features to end up with a functional action-based representation of concepts.

A third featural view is that of Mervis (1987) who suggested it is the nature rather than the number of features attended to that distinguish child and adult semantic knowledge. Both over- and under-extension of child lexical categories may be due to lack of cultural knowledge or cultural conventions - what objects do or how they are used - resulting in lack of awareness of the relevant attributes, underestimation of the salience of an attribute, or incorrect attributes. Through experience with objects and their place within the culture, children learn to attach the right weight to the right features.

Thus the featural explanations differ in the type of change in attention to features they claim to be responsible for the gradual fine-tuning of child toward adult categories: do children add relevant features (Clark, 1973), do they subtract irrelevant features (Nelson, 1974), or do they change attention from child features to (different) adult features and/or attend to the same features but with different weights (Mervis, 1987)? We evaluated these possibilities with respect to later semantic development.

A feature-based account may explain much of the evolution that takes place in later semantic development, but difference in features alone may not fully explain the differences between child and adult lexical categories. Malt et al. (1999) and Ameel et al. (2005) found substantial variability across languages in naming patterns for common household objects even though the perception of similarities among them was

much the same. This dissociation between naming and similarity suggests that in each language there are idiosyncratic mappings between objects and words that contribute to the semantic knowledge attached to a word and that can not be explained by the presence of particular features. These must be mastered through growing experience with the naming of individual objects. We therefore additionally studied to what extent features can fully explain naming differences between children and adults. We expected that the features would not provide a full account of the semantic development reflected in the naming data because of the idiosyncrasies in a language.

Method

Materials. The linguistic categories for which features were generated were extracted from the adult naming data (Ameel et al., 2005). We selected the 6 names that were dominant for the largest numbers of objects for the adults: ‘fles’, ‘bus’, ‘pot’, ‘brik’, ‘doos’ and ‘tube’.

Participants. For each category, ten adults generated features and 18 different adults filled out feature X exemplar matrices with applicability judgments.

Procedure.

Feature generation task. The names were presented to each participant in a random order. We followed Hampton’s (1979) interview procedure that asked questions such as ‘what makes something a typical [or borderline] X?’ to encourage participants to generate as many different features as they could.

After feature generation, all legible responses were tallied for each category name. Synonymous features were counted as the same, and each feature in responses containing multiple features (e.g., ‘are made of transparent glass’) was counted separately. For each name, the seven most frequently generated features were retained to construct the exemplar X feature matrices.

Exemplar X feature applicability task. For each name a matrix was constructed where the columns corresponded to the 73 pictures and the rows were labeled with the seven most frequently generated features for the category, derived from the feature generation task. Participants were asked to fill out all entries in the matrix with a 1 or a 0 to indicate whether or not a feature characterizes the exemplar corresponding to the column of the entry. Completion of an applicability matrix took half an hour on average. Each of the 6 matrices was filled out by 3 participants.

Results and Discussion

Featural changes over the course of development. For each category name, the feature X exemplar matrices were summed over participants. This resulted in seven vectors of summed applicability scores, one for each feature associated with a name. For each age group and for each name, multiple regression analyses were performed in which the percentage of children or adults calling each object by the name was predicted by the vectors of the seven most frequently generated features for the name. Figure 1 shows for the

different age groups the proportion of variance in the naming percentages that was explained by the seven most frequently generated features of each category.

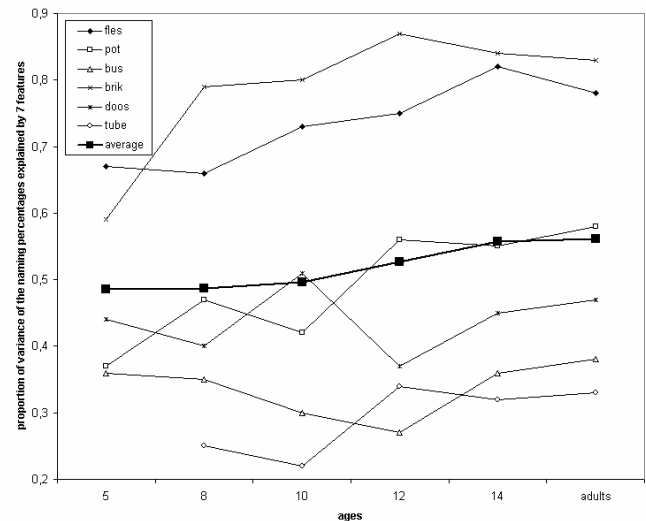


Figure 1. Proportion of total variance in the naming percentages of each category explained by the seven most frequently generated features of the category for the different age groups.³

On average, the proportion of variance explained by the seven most frequently generated features gradually increased from 5-year-olds to adults ($\rho = 1, p < .0001$). Apparently, children gradually learn to attend to the set of features used by adults. However, we found no difference among the age groups in the number of features that were significant predictors of naming. Averaged over all categories 2.6, 3.2, 3.2, 3, 3.5 and 3.3 features were significant, respectively, for the 5-, 8-, 10-, 12-, 14-year-olds and adults. This finding contradicts both the possibility based on Clark’s (1973) Semantic Feature Hypothesis that children are attending to fewer features than adults and the possibility based on Nelson’s (1974) view that children attend to more features than adults. Instead, the features that were significant for the adults were not always significant for the children and vice versa, a finding more consistent with Mervis’ (1987) suggestion that children attend to different features than adults do. For example, the feature ‘is made of glass’ explained a significant portion of the variance in the adult naming percentages for ‘fles’, while this feature was not significant for 5- to 10-year-olds. This feature was only significant from the age of 12 onward. Conversely, the feature ‘has a cap’ was significant for the children from 5- to 14-year-old, but not for the adults. Similar findings were obtained for the other categories.

To further explore which features were subject to attention change from 5-year-olds to adults, we performed simple regression analyses in which the naming percentages were

³ For the 5-year-old children, the naming percentages of ‘tube’ could not be predicted by the seven most frequently generated features, because the name ‘tube’ has never been used by the 5-year-olds.

predicted by one feature at a time for each age group. We only discuss the results for ‘fles’ and ‘pot’, since these are the main names used by the 5- to 12-year-old children and are among the three most used names for the 14-year-olds and adults. For the other categories, the simple regression analyses yielded similar results. Figures 2 and 3 show the proportions of variance in the naming percentages of the different age groups explained by different features of, respectively, ‘fles’ and ‘pot’. For each name, we only selected the features that were significant for at least two of the different age groups in the multiple regression analyses.

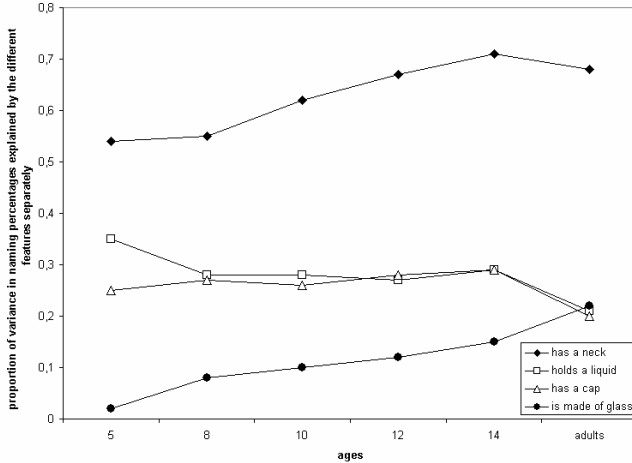


Figure 2. Proportions of variance in the naming percentages of the different age groups explained by the significant features of ‘fles’.

Figure 2 shows that the proportion of variance explained by the features ‘has a neck’ and ‘is made of glass’ gradually increased from 5-year-old children to adults (respectively from 54% to 68% and from 2% to 22%). For the features ‘holds a liquid’ and ‘has a cap’, the opposite pattern was found. For the 5-year-old children, these features explained, respectively, 35% and 25% of the variance in naming, in contrast to 21% and 20% for the adults. This pattern of results explains the phenomenon of over-extension for ‘fles’. When determining whether an object should be called ‘fles’, younger children make less use of the features ‘has a neck’ and ‘is made of glass’ compared to adults. Therefore, younger children will also use ‘fles’ for objects without a neck and objects made of materials other than glass, like ‘bus’ and ‘brik’ objects⁴. Instead, children pay much more attention to whether an object holds a liquid or not and has a cap or not in determining whether ‘fles’ can be applied to it. However, the features ‘holds a liquid’ and ‘has a cap’ do not discriminate among the adult ‘fles’, ‘bus,’ and ‘brik’, which makes again clear why the child use of ‘fles’ also encompasses objects called ‘bus’ and ‘brik’ by adults.

⁴ A multiple regression analysis of the naming percentages of ‘bus’ and ‘brik’ based on the features of ‘fles’ yielded negative regression weights for ‘has a neck’ and ‘is made of glass’, indicating that ‘bus’ and ‘brik’ objects usually do not have a neck and are not made of glass.

In Figure 3, similar findings are shown for ‘pot’: the four features displayed in the graph all became more important over age. Since younger children pay less attention to these features - to them, it does not matter whether an object possess these relevant features or not - the category ‘pot’ is much broader for children than for adults. Unlike for ‘fles’, the analyses did not reveal features that were more important for children than for adults.

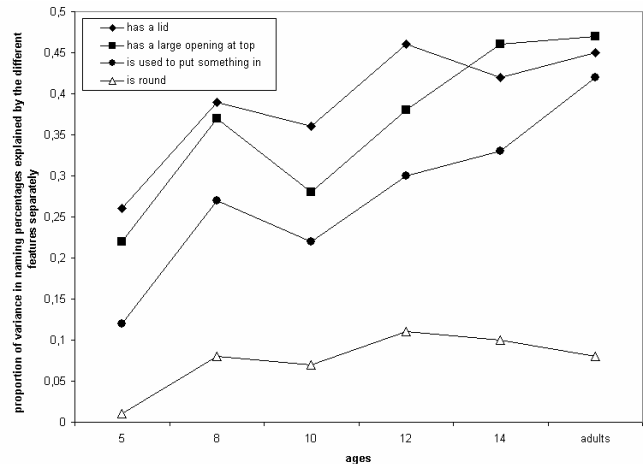


Figure 3. Proportions of variance in the naming percentages of the different age groups explained by the significant features of ‘pot’.

Beyond features. Although changes in the features attended to account for substantial amounts of the shifts in naming, as we expected, even the naming pattern of adults could not be fully explained by the features. The total variance in adult naming explained by the features varied from 33% for ‘tube’ to 83% for ‘brik’, leaving 67% and 17% of the variance unexplained, respectively. In light of the substantial degree of cross-linguistic variability in the composition of the lexical categories partitioning the domain studied here (Malt et al., 1999; Ameel et al., 2005) while similarities among the objects were seen in the same way across languages, we suggest that the additional knowledge is likely in the form of language-specific conventions for certain object-name pairings. These language-specific conventions may be represented by specific combinations of features or by specific values on the main features, not captured in the present feature set.

General Discussion

Our results have important implications for how to understand lexical development once children have established a working grasp of the words covering much of a semantic field. First, Study 1 revealed a substantial evolution in the use of nouns labeling familiar household objects well past the first years of language acquisition, even up to at least the age of 14. The gradual convergence onto the adult naming pattern involved only a minimal increase in words over age. Instead, over-extended words (e.g., ‘fles’) narrowed over age and under-extended words (e.g., ‘bus’) broadened over age. These results suggest that later lexical development is

characterized by reorganization of lexical categories rather than by (or in addition to) new partitions of semantic space through addition of new words.

An interesting finding was that some categories started off broad and narrowed later on, while for other categories the opposite pattern was found. This difference in development may be explained by the degree of heterogeneity of the categories. More heterogeneous categories, containing a wide range of very different exemplars, such as the 'bus' category, may be more difficult to learn than more homogeneous categories and therefore start off narrower. This may be due to the fact that heterogeneous categories are less likely to be represented by a clear set of (adult) features - as confirmed by the low proportion of variance in the adult naming percentages of 'bus' explained by the features (38%). Instead, they may be more likely to be learned through specific stimulus-word associations which must accumulate over time.

Second, the reorganization of the categorical structure seems to be driven by gradual attention shifts to the 'right' set of features, as evidenced by the increasing proportion of variance explained by the adult features over age. Children gradually learn which features are relevant in assigning names to objects and they gradually attach the right weights to them. This finding is in line with Mervis' (1987) suggestion that children attend to different features from adults. If so, the addition of features generated by children as predictors may capture the naming patterns of children to a better degree, and the proportion of variance explained by these child-based features may decrease over age.

Finally, the differences in features alone are not sufficient to explain the reorganizations in later semantic development, as even the naming pattern of adults could not be fully explained by the features. Besides the feature-based account for later lexical development, a second force that may push the child toward greater convergence with adult use is mastery of language-specific idiosyncrasies obtained through experience with the naming of individual objects. More research is required to understand the nature of the learning that underlies mastery of these language-specific conventions.

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