Bilingualism: Language and Cognition 6 (1), 2003, 47–67 © 2003 Cambridge University Press DOI: 10.1017/S1366728903001020

Linguistic diversity and object naming by non-native speakers of English*

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Languages vary idiosyncratically in the sets of referents to which common nouns are applied. To use nouns as a native speaker would, second language learners must acquire language-specific naming patterns, not merely a language-to-language correspondence. We asked second language learners to name household objects in English and in their native language, to judge the objects' typicality with respect to English names, and to provide naming strategy reports. The least experienced learners' naming and typicality judgments diverged substantially from native responses. More experienced learners improved, but even those with the most extensive experience retained some discrepancies from native patterns. Time spent immersed in an English-speaking environment was a better predictor of performance than years of formal instruction. Discrepancies do not appear to be due to direct mapping from the learner's own language. We discuss how incomplete lexical knowledge may affect second language performance and the implications for models of second language lexical development.

The words of one language cannot always be mapped directly onto the words of another. For example, the English words "fate" and "destiny" have no equivalent in some languages (Wierzbicka, 1992). Russian has separate words for one's wife's brother, wife's sister's husband, and husband's brother, all of which would be labeled "brother-in-law" in English (Lyons, 1968), and Spanish uses a single preposition, "en", for spatial relations that are divided into "in" and "on" in English (e.g., Bowerman, 1996). Many such cases of non-equivalence concern words for abstract and socially constructed concepts (e.g., De Groot, 1993; see Pavlenko, 1999, 2002; Altarriba, in press, for further examples). Cross-linguistic differences in such domains are not surprising. For words referring to common artifacts, though, one might expect a closer correspondence. Objects such as tables and chairs, plates and bowls, and shoes and boots are similar in design and use across many cultures. If objects are grouped by name according to their shared properties, languages should make parallel distinctions in labeling everyday artifacts such as these.

Indeed, direct correspondence across languages for words for common objects is often assumed in practical and theoretical approaches to second language vocabulary acquisition. Second language instruction has typically taught vocabulary for familiar objects as a matter of paired associate learning: students learn that "chair" is "chaise" in French or "silla" in Spanish, that "bottle" is "bouteille" in French or "botella" in Spanish, and so on. Psycholinguists studying the process of second language learning have focused on issues such as how to facilitate the learning of the pairs through mnemonic devices or grouping (e.g., Crutcher, 1998; Schneider, Healy and Bourne, 1998), how the existence of cognate pairs might be exploited to speed vocabulary acquisition (Meara, 1993), and whether members of a pair share a common conceptual store (e.g., Potter, So, Von Eckhardt and Feldman, 1984; Kroll, 1993). This idea is consistent with the suggestion that common nouns capture structure in the world that is obvious to all perceivers (e.g., Rosch, Mervis, Gray, Johnson and Boyes-Braem, 1976; Berlin, 1992). Further, some theorists have explicitly suggested that concrete nouns are the strongest candidate for having corresponding conceptual representations across languages (e.g., De Groot, 1992, 1993, 2002; Kroll, 1993).

Observational and experimental evidence now indicates, though, that the assumption of direct mapping is not necessarily correct even for the naming of common, concrete objects. Polish speakers label a telephone table and a coffee table by one word and a dining room table by another, although English speakers use the same label for all three (Wierzbicka, 1992). English speakers use the same name for a large, stuffed seat for one person ("chair") as they do for a smaller wooden seat, but Chinese speakers give the stuffed one the same name that they would give a stuffed multi-person seat (what English speakers would call "sofa"; Gao, personal communication). Kronenfeld, Armstrong and Wilmoth (1985) found that speakers of

* This work was supported by National Institute of Mental Health Grant MH51271 to Barbara Malt and Steven Sloman. We thank Brianna Eiter, Kristy Kulik, Cristina Pacheco, Kevin Reilly, Kristine Schuster, Nuanprang Snitbahn, Molly Stanton, Siri Steinberg, and especially Bonnie Green for assistance with data collection and analysis. Judith Kroll, Gregory Murphy, and three reviewers provided helpful comments on an earlier version of this paper.

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English, Hebrew, and Japanese partitioned a set of 11 ordinary drinking vessels by name in different ways. For example, the American speakers of English grouped together by name a paper drinking vessel and one for drinking tea (calling both "cup"), but the Israeli speakers of Hebrew called them by different names. Speakers of Japanese used three different names in partitioning the objects, which were partitioned by only two different names in English and in Hebrew. Paradis (1979) and Graham and Belnap (1986) provide further examples.

Malt, Sloman, Gennari, Shi and Wang (1999) looked at naming for a set of 60 common containers by speakers of American English, Mandarin Chinese, and Argentinean Spanish and similarly found substantial differences in the naming patterns across speakers of the three languages. For instance, the 16 objects named "bottle" in English were spread across seven different linguistic categories[1] in Spanish, and the Chinese category that contained the 19 objects called "jar" in English also included 13 objects called "bottle" in English and eight called "container". Malt, Sloman and Gennari (in press) examined in more detail the relation among the linguistic categories for the 60 containers and found a complex pattern. Some of the categories shared prototypes across the three languages but others did not; some cases of nesting occurred (the categories of one language were contained within those of another); and some cases of cross-cutting were found (pairs of objects were put into a single category by one language but into different categories by another language).

Both Kronenfeld et al. (1985) and Malt et al. (1999) found that although the naming patterns diverged across speakers of the different languages, judgments of similarity among the objects by those speakers were largely the same. This dissociation of naming from similarity, along with the cross-linguistic variation in naming itself, argues against the sort of universal-prototype model of naming that the idea of direct mapping would suggest. That is, naming must involve something more than, or different from, learning prototypes of universally perceived groupings and the names associated with them, and then labeling objects according to their similarity to the prototypes (e.g., Smith and Medin, 1981; Hampton, 1993). Malt et al. (1999, in press) and Malt, Sloman and Gennari (2003) argue that the naming patterns of a language are influenced by a language's history and the history of the culture that uses it. The vocabulary of each language (or dialect) changes over time and is shaped by factors such as what names happened to exist in that language at earlier times and so were available for extending to new objects, what new names happened to be introduced through language contact or manufacturer invention, what objects were present in the culture at earlier times and formed similarity clusters that were named, what domains have been of particular interest to the culture at some point and so have led to finer linguistic differentiation of the conceptual space, and so on. Such factors contribute to the choices of names a speaker has for an entity and which is dominant. For native speakers, then, a grasp of the linguistic categories of their language must come in part from language-specific knowledge accumulated through extended exposure to individual objects and the names assigned to them by mature speakers, as well as from perception of the properties of the objects themselves.

What of the second language learner, then? This perspective implies that to name objects as a native speaker would, he or she must acquire similar knowledge of language- and culture-specific naming patterns, not merely knowledge of a language-to-language correspondence. But such knowledge is not easy to come by. Paired-associate vocabulary learning in the classroom, and exposure to words in the absence of their referents (for example, in books), does not typically provide such knowledge. Even in an immersion environment, accumulation of the experience needed to generate native naming may be a lengthy process.

These observations lead to several predictions about the acquisition of native naming patterns for common objects by second language learners. First, naming patterns for learners with relatively modest levels of experience with the second language will not fully match those of native speakers even when basic vocabulary for the domain has been acquired. Second, because of their incomplete grasp of the membership of the linguistic categories (and hence the central tendencies), these learners' identification of the linguistic category prototypes, as reflected in judgments of object typicality, will also tend to be poor. Third, as the level of experience with the language increases, naming patterns will become more similar to those of native speakers because learners will acquire more exposure to specific object-name pairings. Fourth, judgments of typicality for learners with a higher level of experience should also more closely match those of native speakers, because they have gained more experience with the linguistic category membership. Finally, for all learners, years of immersion in an English-speaking environment should be a more important predictor of match to the native naming pattern than years of formal instruction, because it is exposure to individual instances and the names they receive that is critical to mastering the second language

[1] By "linguistic category" we mean any set of objects that shares a name in a given language (or for a given speaker). We do not assume that linguistic categories correspond directly to conceptual groupings of objects. The cross-linguistic variability in naming, along with the dissociation between naming patterns and perceived similarity discussed below, suggests, in fact, that they do not (see also Sloman and Malt, in press, for arguments against assuming fixed conceptual groupings of objects).

categories, not merely instruction based on direct mappings or exposure to words in the absence of their referents.

These predictions contrast with those that would follow from a view in which concrete nouns correspond directly across languages. Under such a view, learners with any level of experience, once they have acquired vocabulary for a domain, should be able to generate appropriate usage and typicality judgments, and classroom learning should be as effective as immersion experience in providing mastery of the correspondence.

In the study presented here, we asked second language learners with different levels of experience with English to name ordinary household objects in English and in their native language. They also judged the typicality of the objects with respect to the major linguistic categories used for the objects by native speakers, and they provided reports on the strategy they felt they were using in naming in English. We used the English naming data and typicality judgments along with information about their language histories to test the central predictions.

The data also allow us to address two subsidiary questions. First, is age of acquisition related to performance? This variable has been proposed as an important predictor of mastery of syntax, morphology, and phonology in second language learning (e.g., Krashen, Long and Scarcella, 1982; Johnson and Newport, 1989; Singleton, 2001). In general, semantics has not been included in discussions of critical periods for language learning. An implicit assumption is that learning meanings or uses of words is like domain-general learning of other sorts and so would not be affected by critical periods that may exist for other aspects of language acquisition. Indeed, recent work has explicitly proposed that word learning draws on domain-general mechanisms (e.g., Markson and Bloom, 1997; Smith, 1999; Bloom, 2000). However, this proposal remains controversial (e.g., Markman, 1992; Waxman and Booth, 2000, 2001). Furthermore, even if word learning proceeds in a domain-general fashion, the more firmly entrenched native linguistic categories are (i.e., the longer they have been held), the harder it may be to acquire second language categories that do not map directly onto the native categories (e.g., MacWhinney, 1992). Our data will allow us to assess the importance of age of acquisition to performance on our naming measure.

Second, exactly how might the fact of an incomplete knowledge base result in the naming patterns that learners generate? The most obvious explanation is that learners try to map directly from a word in the native language to a word in the target language. The observation that classroom vocabulary teaching is typically treated as paired-associate learning, with lists of word equivalents to be learned, suggests that learners in the earliest stages of acquisition may use such a strategy. In addition, research on lexical retrieval in bilinguals (e.g., Kroll and Curley, 1988; Kroll and Stewart, 1994) suggests that such learners access words in the second language lexicon through their links to words in the native lexicon. However, this research also indicates that as learning progresses, learners develop direct connections between conceptual knowledge and words in the second language lexicon, and they can access this lexicon without mediation from the native lexicon. The strategy reports, along with data from naming in the native language, will allow us to assess whether discrepancies from native naming derive from attempting to map words of the native language directly onto English words, or whether our learners avoid a direct mapping strategy but still fail to generate correct usage. We consider in more detail why errors may be generated in the latter case in the general discussion section below.

Method

Participants

Sixty-eight non-native speakers of English participated in a three-session experiment, 51 from Lehigh University and 17 from Brown University. Approximately 75% were undergraduates, with the remainder being graduate students or their spouses. About 60% were male. About 60% were from the Introductory Psychology subject pool at Lehigh University and participated for course credit. The remaining participants responded to solicitations around the campuses and were paid for their participation. The language history questionnaire described below provides information about the demographics of our 68 participants. They spoke a total of 32 different languages from Indo-European and non-Indo-European language families. Most heavily represented were Korean (5 participants), Thai (6), Spanish (9), and several dialects of Chinese (15). All but two participants considered themselves to have one native language, with the remaining two reporting having learned two (neither being English) from birth. Years of immersion in an English-speaking environment ranged from a few weeks (for newly arrived freshmen) to 18 years. Years of formal instruction in English ranged from 1 to 18. Self-estimates of proficiency ranged from 0 to 10.9 out of a maximum of 11.

Data from native speakers of English were used for comparison. The native speakers were undergraduates at Lehigh University whose naming and typicality data had been collected for purposes of other, related studies (Malt et al., 1999, in press; Stanton, 1999; Sloman, Malt and Fridman, 2000, 2001), using the same instructions as in the current study. 28 speakers provided naming data for the bottles stimulus set and another 28 gave typicality judgments for this set; 24 speakers each did both the naming and typicality tasks for the dishes set.

Materials

Language history questionnaire

A questionnaire was used to determine participants' language background and the nature of their exposure to English. Questions asked about age and sex; native language(s) and languages other than English learned; age of beginning to learn English; number of years of formal instruction; number of years in an English-speaking environment and any locations outside the U.S. in which the participant had spent those years; which language he or she currently uses most; and estimated proficiency. The proficiency estimate was obtained by asking participants to put a slash at the appropriate place on a scale labeled from "low (can barely speak it)" to "high (like a native speaker)". Similar self-report measures have been shown to correspond well with performance measures of proficiency such as reaction time on a verbal categorization task (e.g., Dufour and Kroll, 1995; Kroll, Michael, Tokowicz and Dufour, 2002).

Objects named

Stimuli consisted of 60 pictures of storage containers and 60 of housewares for preparing and serving food. Both sets had been developed for previous studies (Malt et al., 1999; Stanton, 1999; Sloman et al., 2000, 2001). For the first set, objects had been selected to be likely to receive the name "bottle" or "jar" in American English or else to have one or more salient properties in common with bottles and jars but be likely to receive some other name (hereafter referred to as the "bottles set"). For the second set, objects had been selected to be likely to receive the name "dish", "plate", or "bowl" in American English (hereafter, the "dishes set"). The objects were all found at home, work, or in grocery, drug, and other stores frequented by the researchers. For both sets, an effort was made to include objects that would span as wide a range of sizes, shapes, and uses as possible while still receiving one of the target names in English. This range allows a sensitive assessment of how naming patterns differ across languages and how non-native naming may differ from the native naming pattern. The Appendix provides informal descriptions of the objects in the two sets, incorporating the name most frequently used for each object by the native speakers. In the bottles set, labels on the objects were retained to provide participants with as much information as possible about their intended use. Labels typically identified the substance contained in the object but in no case did they give a name for the container itself. All objects were photographed in color and presented to participants as 4″ x 6″ photographs. To preserve size information, objects were photographed to scale as much as possible (the image size for the largest objects was reduced slightly). All objects were photographed on a neutral background with a ruler in front of them to provide additional size information. Black and white images of some of the color photographs appear in Figures 1 and 2 (see also Figure 5 in Malt et al., 1999 and Figure 1 in Malt et al., 2003).

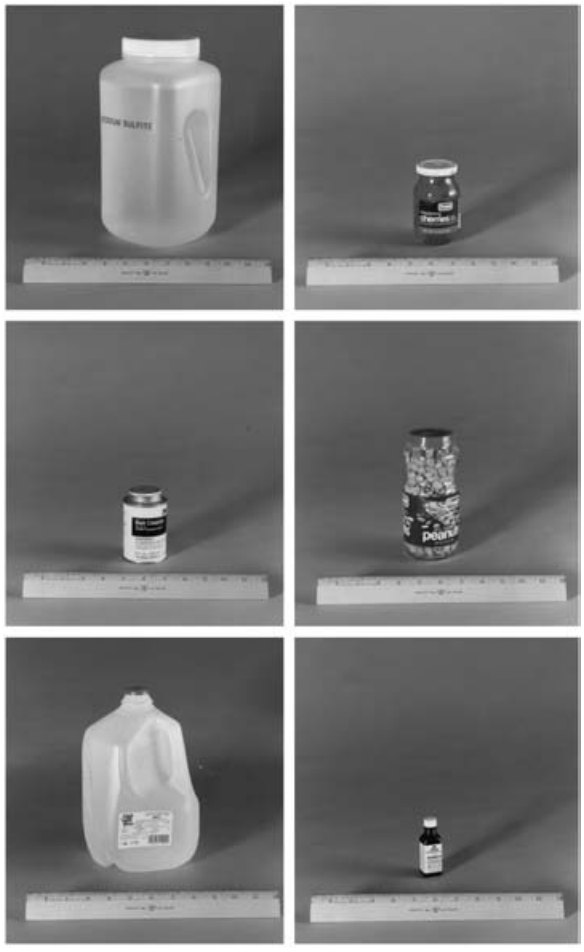

Figure 1. Sample stimuli from the bottles set.

Strategy report questionnaire

Subjective reports of the strategies used to choose names were collected on a questionnaire. Five choices were given: (a) that names just "felt right" for objects; (b) that translation equivalences were used (e.g., "'jar' is equivalent to the word __ in my language"; participants were asked to fill in the blanks with the equivalences used); (c) that specific features were used (e.g., "I called things 'jar' if they had the features __"; participants were asked to fill in the features used); (d) that they guessed because they didn't know the right name; (e) that some other strategy was used (participants were asked to specify what it was).

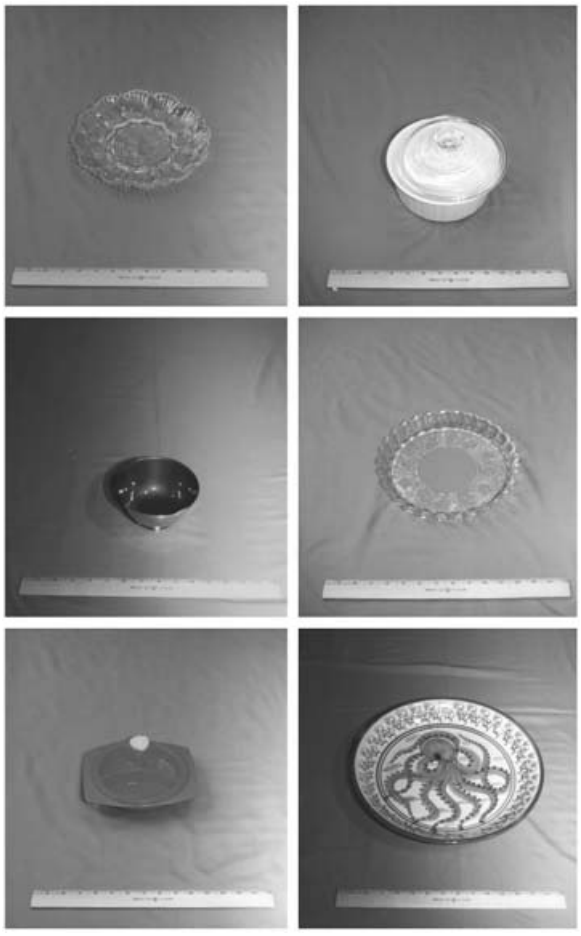

Figure 2. Sample stimuli from the dishes set.

Procedure

Participants were tested individually in three sessions of approximately one hour each. In the first session, they filled out the language history questionnaire. They then were told that they would first be asked to look at pictures of familiar objects and provide names for the objects in English, and they were handed a set of pictures to look through so they could see the range of objects. The set was shuffled before use, and approximately half the participants received bottles in the first session and half received dishes. Participants were asked to say, for each object, what name they thought they would call it in an ordinary conversation in English. They were told that they could give a single-word name or more than one word, and that some of the objects might be hard to name but they should try to give an answer for each one. The experimenter recorded responses in a spreadsheet.

After naming was completed, participants received the strategy report questionnaire. They were instructed to circle the strategy they thought they used, or, if more than one, to rank order them, and to fill in the blanks as relevant (listing native language equivalents if choosing strategy A and features used if choosing strategy B). Typicality ratings were then collected. Ratings were collected for each object's membership in the three linguistic categories that were dominant for the set given by previous American English speaking participants (Malt et al., 1999; Sloman et al., 2000, 2001). For the bottles set, these were "bottle", "jar", and "container", and for the dishes set, they were "dish", "bowl", and "plate". Participants first rated every object for its membership in one category, then for the second category, and then for the third, with pictures shuffled before each category. Responses were given on a scale of 0 ("not a member of the specified category") to 7 ("very typical of the category"). Participants were told that ratings for each category should be independent of earlier responses, so that, for instance, an object could be rated as a bottle even if they had given a different name for it or had rated it to be a typical member of another category already. Order of categories for each stimulus set was rotated across participants. The experimenter recorded responses in the spreadsheet.

Finally, familiarity ratings were collected for the objects. Participants rated each object on a scale of 0 ("never seen this type of object before") to 7 ("very familiar") indicating how familiar they were with that sort of object. Instructions indicated that the participant did not have to be familiar with the very same object (that is, with the same label or pattern) but rather with an object similar in appearance and use in order to consider that they had seen that type of object before.

The second session was similar to the first, except that participants did not complete the language history questionnaire, and the tasks they carried out were for the picture set not used in the first session.

In the third session, participants completed the naming and typicality tasks with respect to the linguistic categories of their native language, for both sets of pictures. They first named one set of objects in their native language. The participant him- or herself was asked to record each name next to the appropriate stimulus number on a sheet of paper in order to ensure correct spelling of the names. Because the experimenter would have had difficulty identifying and matching the head nouns of phrases in some cases, especially for languages with non-Roman alphabets, the participant was asked to help determine which three names were the most frequent in his or her responses. The participant made a list of the different names used and tallied how many times each one appeared among their responses for the set. Typicality ratings were then carried out for each of the three most frequent categories determined by the tally. The naming and typicality rating procedures were carried out again in the same way for the second set of pictures. (The typicality ratings will not be reported in this paper.) Order of picture sets was balanced across participants.

Results and discussion

Familiarity with the stimuli

Although participants who come to the United States for higher education are likely to have come from environments where they were exposed to the sort of objects in our stimulus sets, overall, the non-native speakers may have had less prior exposure to the objects tested than native speakers. If that is the case, lack of understanding of the nature of the objects might account for discrepancies in naming them. The familiarity ratings suggest that that is not the case. The mean familiarity rating for the bottles for the non-native speakers was 5.60 (s.d. = 1.17) and it was 5.03 (s.d. = 1.21) for the dishes (out of a maximum of 7). These means are closely comparable to mean familiarity ratings for the same objects given by native speakers of English (Malt et al., 1999; Sloman et al., 2000, 2001); the mean for bottles from 15 native speakers was 5.11, s.d. = 1.20, and the mean for dishes was 4.30, s.d. = 1.40. Furthermore, the non-native ratings were very similar to those of the native speakers even for participants with a limited amount of time living in the U.S.: the 22 participants in our least experienced learners learner group (described below) had mean ratings of 5.48 (s.d. = 0.94) for bottles and 4.96 (s.d. = 0.98) for dishes.

Because the familiarity ratings for the non-native speakers were taken after exposure to the pictures in the experimental tasks, it might be suggested that this exposure was the basis for their judgments of familiarity with the objects. This possibility is inconsistent with the observation that participants used the full range of the 0 to 7 scale in reporting familiarity. In addition, the non-native mean item ratings correlated with those of the native speakers .54 ($p < .005$) for bottles and .84 ($p < .005$) for dishes, demonstrating a substantial correspondence between the native and non-native speakers in which objects they considered ordinary. The correlations were only slightly lower for the 22 least experienced learners, who had been in the U.S. no more than 5 years, $r = .47$ ($p < .005$) for bottles and $r = .77$ ($p < .005$) for dishes; these values do not differ significantly from those of the non-native group as a whole, $z = .5$ for bottles and 1.12 for dishes, $p > .10$ for both. In sum, differences in understanding of the nature of the objects are not a likely basis for any divergence of naming patterns between our second language learners and native speakers.

Naming and typicality judgments

Group characteristics

To assess naming and typicality judgments over the course of second language learning, we divided our participants into three groups that captured major clusters in the extent of overall experience with English in our sample. The LEAST EXPERIENCED LEARNER GROUP consisted of those who had been in the U.S. for five or fewer years and who had had eight or fewer years of formal instruction in English, a total of 22 participants. The MOST EXPERIENCED LEARNER GROUP consisted of those who had been in the U.S. for eight or more years and who had had ten or more years of formal instruction in English, a total of 14 participants. The remaining 32 participants – those who fell in between the least and most experienced groups – were considered to be INTERMEDIATE IN EXPERIENCE. Table 1 gives the means and medians for years of formal instruction, years of immersion in an English-speaking environment, and self-estimates of proficiency for each group. The increases in self-estimates of proficiency across the three groups suggest that our grouping criteria capture meaningful differences in overall mastery of English as well as level of experience with the language.

Least experienced learners

We first examine the performance of the least experienced learner group to determine whether it differs from that of native speakers. Note that although the members of this group have had less exposure to English than the other participants, they are not beginners in learning English. Discrepancies between their use of common vocabulary words and that of native speakers are unlikely to be from sheer unfamiliarity with the words themselves. Most of the participants were full-time undergraduate or graduate students in American universities at the time of test, indicating that their English was adequate for communication in the classroom and on written papers and exams. All were able to follow a series of fairly complex instructions in English to complete the experiment. The self-estimates of proficiency indicate that, indeed, these speakers consider their level of mastery to be moderate rather than low.

In addition, the responses of the participants provide direct evidence about their vocabulary knowledge relative to the demands of the task. The names for our two object sets that were most commonly used by native English speakers ("bottle", "jar", and "container" for the bottles set; "dish", "plate", and "bowl" for the dishes set) are all moderately high in frequency according to the CELEX[2] database (Baayan, Piepenbrock and Gulikers, 1995) of 17.9 million words of spoken and written English discourse (with frequencies of 2079 for "bottle", 335 for "jar", 217 for "container", 504 for "dish", 995 for "plate",

[2] The CELEX database is derived from samples of British English, and occasional deviations from American frequencies may occur. However, it is the largest and most up-to-date database of English language frequencies available, and occasional small deviations are inconsequential to the overall point for which they are consulted here.

Table 1. *Language experience of learners, grouped by joint criteria of years of immersion in an English-speaking environment and years of formal instruction.*

Speaker group	Years in an English-speaking environment	Years of formal instruction	Proficiency self-estimate
Least experienced	mean: 2.26	mean: 6.07	mean: 5.97
learners (n = 22)	median: 2.0	median: 7.0	median: 5.5
Intermediate	mean: 4.51	mean: 10.5	mean: 7.69
learners (n = 32)	median: 5.0	median: 10.0	median: 8.1
Most experienced	mean: 13.5	mean: 12.78	mean: 9.34
learners (n = 14)	median: 14.5	median: 12.50	median: 10.65

and 591 for "bowl"). The least experienced learners showed knowledge of a range of vocabulary words of this frequency and below for the domains of the two stimulus sets. They produced a mean of six different nouns for the bottles set (median: 6) and 6.9 (median: 7) for the dishes set, with a mean of 11.9 (median: 12) unique words per person (i.e., excluding words that overlapped between the two sets). Their labels for the objects included words such as "ashtray" (frequency: 161), "casserole" (frequency: 94), and "carton" (frequency: 83). The mean frequency of the head nouns produced by each speaker outside of the six names dominant for native speakers was 553.[3] These speakers also demonstrated an elaborate vocabulary of modifiers for the objects including low-frequency words such as "porcelain" (frequency: 108), "cylindrical" (frequency: 13) and "ointment" (frequency: 62). Because the task did not require that modifiers be used, not all speakers produced them, but the most common type of modifier, words or phrases describing the typical contents of the objects (e.g., "lotion" or "peanut butter"), was produced by most participants. A mean of 8.7 (median: 5) different modifying phrases describing contents were produced for bottles by the 18 participants who produced any, and a mean of 5.8 (median: 5) were produced for dishes by the 16 participants who produced any, with a mean of 12.3 (median: 10.5) unique phrases per participant. The mean frequency of the words in the contents descriptors produced by each speaker was 1036; the median was 646.[4] In sum, the least experienced learners appeared to have substantial vocabularies at and below the frequency range of the labels most commonly used for the objects by native speakers, including words within the same container domains as the stimuli. In general, lower frequency words will tend to be encountered and acquired (and are also taught) later than higher frequency words. Any failure to produce one of the nouns commonly used by native speakers,[5] or failure to apply such nouns to the same objects that the native speakers did, thus can be taken as indicative of a poor understanding of the distribution of the word, not a simple lack of familiarity with the more common vocabulary words for the domain.

In the analyses here and throughout the results, occasional variations in degrees of freedom occur. These small variations are primarily due to a few participants not having completed all measures because of time constraints. Also, occasionally a participant failed to respond to a question on the language history questionnaire, and so analyses using that demographic variable omit data for that person.

Naming. We predicted that for the least experienced learners, naming patterns would tend to mismatch those of native speakers even though basic vocabulary for the domain has been acquired. We calculated the extent to which our least experienced learners matched the naming patterns produced by the native speaker comparison groups for the two sets of objects. Because there was some variability in the names produced for most of the objects by native speakers, we gave the non-native speakers credit for their naming choice, for each object, proportional to

[3] This calculation omits one outlier. One participant used the word "thing" once, which has a frequency of 18,602.

[4] This calculation omits all words for the bottles set that participants might have read off the object labels in the pictures. (No words occurred on objects in the dishes set.)

[5] The least experienced learners did occasionally fail to use a name dominant for one or more objects for the native speakers, so we cannot simply say that each person provided evidence for familiarity with the full set of names dominant for native speakers. However, the same is true for individual native speakers: for instance, although "jug" is the dominant name for three objects in the bottles set for native speakers, only about half of the native speakers actually used this name for each object, and some native speakers never produced the word "jug". It must be expected, then, that the set of dominant names produced by the aggregate native sample will not be fully reproduced by each individual member of the least experienced group.

Table 2. *Mean weighted naming overlap scores (and standard errors) for native speakers, and for non-native speakers grouped using joint criteria of years of immersion in an English-speaking environment and years of formal instruction.*

	Stimulus set	
Speaker group	Bottles	Dishes
Least experienced learners	.35 (0.02)	.36 (0.02)
Intermediate learners	.42 (0.02)	.36 (0.02)
Most experienced learners	.52 (0.02)	.40 (0.03)
Native	.59 (0.01)	.48 (0.01)

the frequency with which their choice was used by native speakers for that object. Thus, for instance, if an object had been called "bottle" by 75% of the native speakers, "container" by 20%, and "jar" by the remaining 5%, a non-native speaker would receive a score of .75 for calling it "bottle", a score of .20 for calling it "container", a score of .05 for calling it "jar", and a score of 0 for calling it by any other name. The mean scores for the least experienced learners for each stimulus set are given in the first row of Table 2.

To interpret these numbers, it is necessary to have a comparable measure for native speakers. Because of the variability in native naming, each native speaker also will not receive the highest possible score; he or she will sometimes have given a name for an object that was not used by most of the other native speakers. We therefore scored each individual native speaker's naming choices against the native speaker frequency distribution in the same way that the least experienced learners were scored.[6]

[6] To be fully comparable to the scoring for the least experienced learners, the contribution of the name produced by each native speaker for each object should be removed from the group frequency distribution. Actually doing so would require recalculating the entire name X object frequency matrix for each native speaker. In practice, however, the potential impact of removing each native speaker's contribution from the frequency matrix can be seen more simply. For the bottles stimuli, there were 28 native speaker participants. The maximum impact occurs in cases where that person was the only one to use a particular name for an object. In the original matrix, the weight for that name for that object would be 1/28 or .036. Removing that person's input would make the weight for that name 0/27 or 0. The difference is thus .036. In cases where the person produced a name used by more of the other participants, the impact would be less; for instance, if the original frequency was 26/28 and the adjusted frequency is 25/27, the difference in weight entering the scoring is .002. Each object score can thus be impacted by a maximum of .036 to a minimum of 0 (for cases that were originally 28/28 and become 27/27). Because people are, by definition, more often giving high than low frequency responses, the average impact on a person's overall score will be closer to 0 than to .036. For the dishes stimulus set, 24 native speakers responded; therefore, the potential impact is based on shifts from 1/24 to 0/23, etc. The maximum impact is .042 and the minimum is 0; again, the average impact will be closer to 0 than to .042. For both stimulus sets, then, the potential impact on mean scores is small. Subtracting the midpoint of the possible impact from each score (.018 for bottles and .021 for dishes) yielded no difference in patterns of significance for either stimulus set.

The mean native scores for the bottles and dishes set are given in the last row of Table 2. The difference between the least experienced learners and the native speakers for the bottles set was significant by a t-test, $t(48) = 9.43$, $p < .001$, and the difference for the dishes set was also significant, $t(43) = 5.96$, $p < .001$. Thus, the least experienced learners clearly show a discrepancy from native speakers in their use of terms for the two sets of ordinary household containers.

The discrepancies that occurred include both errors of omission (failing to use a word where native speakers did even though the learner had demonstrated knowledge of the word by using it for other objects) and errors of commission (using a word for objects beyond the ones that native speakers did). For instance, one learner used "bottle" appropriately for some objects but called several small bottles "vial", and he also called two objects labeled "can" by native speakers "pressure bottle". This same learner used "dish" appropriately for some objects but called a glass baking dish a "baking container" and called a divided plate (labeled "plate" by 100% of native speakers) a "dish for sorting food". Another learner who used "dish" many times where native speakers did called a rectangular plastic soap dish with a lid a "soap box". This same learner also called many objects "dish" that native speakers called "bowl", such as a large wooden salad bowl and a child's plastic bowl. Such errors reflect a deficiency in understanding the pattern of use of the words, not lack of basic knowledge about the words per se.

Typicality. We predicted that for the least experienced learners, identification of the linguistic category prototypes would tend to be poor, with the result that judgments of typicality would deviate from those of native speakers. To examine typicality gradients, we correlated the typicality judgments for the objects as members of each category that were given by each member of the least experienced learner group with the mean judgments from the native speakers.

The mean correlations for the least experienced learners are given in the first line of each part of Table 3. As can be seen, there is considerable variability in how well the judgments of the least experienced learners matched those of the native speakers. They did relatively well at matching judgments of "jar", "bowl", and "plate", and relatively poorly at matching judgments for "bottle", "container", and "dish".

To judge whether these levels deviate from the level of agreement with the group means that would be achieved

Table 3. *Mean correlation (and standard deviation) of typicality judgments for individual native and non-native speakers with the native group mean typicality judgments. Non-native speakers are grouped using joint criteria of years of immersion in an English-speaking environment and years of formal instruction.*

	Bottles stimulus set Linguistic category		
Speaker group	Bottle	Jar	Container
Least experienced learners	.38 (0.30)	.68 (0.34)	.26 (0.28)
Intermediate learners	.41 (0.29)	.72 (0.36)	.32 (0.22)
Most experienced learners	.57 (0.28)	.88 (0.06)	.20 (0.28)
Native	.64 (0.15)	.86 (0.07)	.46 (0.17)
	Dishes stimulus set Linguistic category		
Speaker group	Bowl	Dish	Plate
Least experienced learners	.68 (0.26)	.38 (0.29)	.73 (0.12)
Intermediate learners	.71 (0.25)	.38 (0.28)	.74 (0.25)
Most experienced learners	.74 (0.12)	.30 (0.30)	.74 (0.17)
Native	.81 (0.05)	.38 (0.33)	.86 (0.07)

by individual native speakers, we calculated the parallel measure of how well individual native speakers matched the native mean typicality judgments. We removed each native speaker from his/her group and calculated the correlation of that participant's judgments with the mean judgments from the rest of the group. The mean individual correlations for native speakers calculated in this manner are given in the last line of each part of Table 3.

Three points are noteworthy about the comparison. First, the least experienced learners fell significantly below the levels of the native speakers overall, $F(1, 43) = 34.67$, $p < .001$, and were below them for five out of the six individual categories ("bottle", $t(48) = 4.06$, $p < .001$; "jar", $t(47) = 2.89$, $p < .01$; "container", $t(48) = 3.17$, $p < .005$; "bowl", $t(44) = 2.38$, $p < .05$; and "plate", $t(44) = 4.16$, $p < .001$ (the Bonferonni adjusted critical value is .008). The two groups did not differ for "dish" ($t(44) = .06$, $p = 1.0$). As predicted, then, the least experienced learners deviate from native speakers in their understanding of the typicality gradients associated with these words. Second, the learners fell particularly far below the level of the native speakers for the category "bottle". Third, the native speakers, like the learners, showed considerable variability in how well they individually matched the group mean. In particular, the means for "container" and "dish" were substantially lower than for the other categories. We will comment further on the variable performance across linguistic categories after additional typicality data have been presented.

The progression of learning

Naming. We predicted that with more experience with English, naming patterns would converge on those of native speakers. The mean scores for the intermediate and most experienced learners for the two stimulus sets are shown in the middle rows of Table 2. A progression of learning across the three levels of experience with English can clearly be seen for the bottles stimuli. There was a significant overall effect of learner group, $F(2, 61) = 9.49$, $p < .001$, with the intermediate group scoring higher than the least experienced learners, $t(50) = 2.20$, $p < .05$, and the most experienced group scoring higher than the intermediates, $t(40) = 2.66$, $p < .02$. The native naming pattern for the dishes stimuli appears to be harder to learn. Although the most experienced group shows numerical improvement over the first two groups, there is no significant effect of learner group, $F(2, 64) = 0.8$, and the most experienced group is not significantly different from either the least experienced learners, $t(33) = 1.1$, or the intermediate learners, $t(44) = 1.15$, all ps $> .05$. Thus, learning of native naming patterns did take place over time for the bottles set, but little improvement occurred for the dishes set.

We can also ask if the performance of the most experienced learners actually matched that of native speakers. The mean score for the most experienced learners was significantly lower than the mean native score for both bottles, $t(38) = 2.64$, $p < .025$, and dishes,

$t(36) = 3.5$, $p < .001$. These analyses, then, indicate that more experienced learners of English improved in their grasp of native naming patterns (at least for some categories), but even with high levels of experience with English they did not become fully native-like in their naming.

Typicality. We predicted that identification of the linguistic category prototypes would improve as learning progresses, with the result that judgments of the typicality gradients would more closely match those of native speakers. The middle rows in each part of Table 3 give the correlation of typicality judgments with those of native speakers for the intermediate and most experienced learners. The most experienced learners did not differ significantly overall from the least experienced learners, $F(1, 31) = 2.63$, $p > .10$. However, the correspondence for the individual categories "bottle" and "jar" did improve over the course of learning, with the most experienced learners showing significantly better correspondence than the least experienced learners, $t(32) = 1.86$, $p < .05$ for "bottle" and $t(31) = 2.03$, $p < .025$ for "jar". Correspondence for "plate" and "bowl" stayed at about the same fairly high level, and for "container" and "dish" stayed low. Thus, learners did show evidence of slow mastery of the prototypes, but they did not do so uniformly across categories. The overall correspondence of the most experienced learners with native speakers remained significantly below that of individual native speakers with the native speaker group, $F(1, 34) = 8.89$, $p < .005$. This difference was due primarily to a lower correspondence for "container", $t(38) = 3.68$, $p < .001$, "bowl", $t(36) = 2.47$, $p < .02$, and "plate", $t(36) = 2.92$, $p < .01$ (the Bonferonni adjusted critical value is.008). The two groups did not differ for "bottle", $t(38) = 1.0$, $p < .4$, "jar", $t(38) = -0.48$, $p < .6$, and "dish", $t(36) = .84$, $p < .5$.

Relation of naming performance to formal instruction and years of immersion

So far we have examined performance using an overall measure of level of experience with English that takes into account both years of instruction and years in an English-language environment. However, our view of how native naming patterns are acquired makes the prediction that years of immersion in an English-speaking environment will be a more important determinant of mastery than years of formal instruction. To test this prediction, we examined the ability of each variable to predict the match to native naming score. The correlation of years of formal instruction in English with the weighted matching score was 0.22 for bottles and 0.21 for dishes, $p < .05$ for both (one-tailed). The correlation of years of immersion with the weighted matching score was .54 for bottles and .36 for dishes, $p < .005$ for both (one-tailed). Thus, as expected, years of immersion had a closer relation to mastery of native naming than classroom learning. A multiple regression showed that when the effect of years of immersion is removed, years of formal instruction had no additional predictive value for matching scores ($\beta = 0.05$ for bottles, $p > .64$; $\beta = 0.13$ for dishes, $p > .30$). In contrast, when the effect of years of formal instruction was removed, significant predictive value remained for years of immersion ($\beta = 0.53$ for bottles, $p < .001$; $\beta = 0.33$ for dishes, $p < .01$).

Table 4. *Mean weighted naming overlap scores (and standard errors) for native speakers, and for non-native speakers grouped using years of immersion in an English-speaking environment.*

	Stimulus set	
Speaker group	Bottles	Dishes
Less than 1 year	.33 (0.03)	.29 (0.02)
1 to 4 years	.38 (0.03)	.38 (0.02)
5 to 9 years	.46 (0.02)	.36 (0.02)
10 or more years	.53 (0.02)	.42 (0.02)
Native	.59 (0.01)	.48 (0.01)

Reprise: performance measures for groups defined by years of immersion in an English language environment

Because years of immersion in an English language environment proved to be a better predictor of scores than years of formal instruction, we can re-examine the performance of learners based only on their years of immersion. Most importantly, we can ask whether the most experienced learners as determined by this measure are indistinguishable from native speakers. We grouped the participants into four groups of roughly equal size: those with less than 1 year (17 participants), those with 1–4 years (18 participants), those with 5–9 years (16 participants) and those with 10 or more years (17 participants).

Naming. The mean weighted matching scores for the four groups are given in Table 4. The groups differ significantly for both bottles, $F(3, 63) = 10.47$, $p < .001$, and dishes, $F(3, 63) = 8.18$, $p < .001$, with a progressively better match to the native speaker naming pattern for both sets. In contrast to the analysis based on the combined measure of learning experience, the most experienced group here does show significant improvement over the earliest learners for the dishes set, $t(31) = 5.40$, $p < .001$, and over the third group, $t(30) = 2.1$, $p < .05$, though not

Table 5. *Mean correlation (and standard deviation) of typicality judgments for individual native and non-native speakers with the native group mean typicality judgments. Non-native speakers are grouped using the criterion of years of immersion in an English-speaking environment.*

	Bottles stimulus set Linguistic category		
Speaker group	Bottle	Jar	Container
Less than 1 year	.30 (0.29)	.62 (0.42)	.23 (0.28)
1 to 4 years	.41 (0.28)	.65 (0.40)	.29 (0.30)
5 to 9 years	.49 (0.25)	.80 (0.19)	.36 (0.17)
10 or more years	.58 (0.27)	.86 (0.08)	.21 (0.25)
Native	.64 (0.15)	.86 (0.07)	.46 (0.17)
	Dishes stimulus set Linguistic category		
Speaker group	Bowl	Dish	Plate
Less than 1 year	.71 (0.08)	.44 (0.32)	.72 (0.11)
1 to 4 years	.76 (0.06)	.35 (0.30)	.76 (0.11)
5 to 9 years	.60 (0.46)	.35 (0.26)	.71 (0.36)
10 or more years	.74 (0.11)	.34 (0.26)	.76 (0.16)
Native	.81 (0.05)	.38 (0.33)	.86 (0.07)

over the second group, $p = .2$. Notably, however, the most experienced learners still scored significantly below native speakers for both bottles, $t(39) = 2.47$, $p < .02$, and dishes, $t(38) = 3.06$, $p < .005$.

Typicality. For typicality judgments, the pattern again replicates that found earlier. The mean correlations are given in Table 5. Correspondence of non-native typicality judgments improved over time, with an overall significant difference between the least and most experienced learners, $F(1, 26) = 6.52$, $p < .02$, a difference primarily due to improvement for "bottle", $t(28) = 2.72$, $p < .02$, and "jar", $t(28) = 2.0$, $p < .05$ (the Bonferonni adjusted critical value is .008). There was little improvement from the already fairly high levels for the least experienced learners for "plate" and "bowl", and no improvement from the low values for "dish" and "container". Despite the gains for some categories, the level for the most experienced learners remained significantly below that of native speakers overall, $F(1,34) = 11.03$, $p < .002$. This discrepancy is mainly due to lower scores for the categories of "container", $t(38) = 3.78$, $p < .001$, "bowl", $t(38) = 2.8$, $p < .01$, and "plate", $t(38) = 2.57$, $p < .01$ (the Bonferonni adjusted critical value is .008). There was little difference in scores for "bottle", $t(38) = .98$, "jar", $t(39) = .13$, or "dish", $t(38) = .4$, ps $> .05$.

We noted earlier the variation across categories in the level of match of individual native speakers to the group native mean. We have now also seen, in several different analyses, variability across categories in the learners' match with the group native mean, and variability across categories in how close the most experienced learners come to the level of match of native speakers with the group native mean. The specific outcomes appear to reflect the structure of the linguistic categories involved, as revealed in previous scaling solutions of the judged similarity among the objects in our stimulus sets[7](Malt et al., 1999, for the bottles set; Stanton, 1999, for the dishes set). The scaling solution for the bottles set showed that the objects called "jar" form a fairly tight cluster in similarity space; those called "bottle" include a clustered subset but also spread across other regions of the similarity space; and those called "container" are the most spread-out and irregularly bounded. The scaling solution for the dishes set showed that the objects called "bowl" and "plate" form relatively well-defined clusters, while those called "dish"

[7] The scaling solutions provide visual representations of the judged similarities among the objects. For the bottles set, a multi-dimensional scaling (MDS) solution was produced (Shepard, 1974). For the dishes set, an additive tree structure was used (Sattath and Tversky, 1977) because MDS did not provide a good fit in low dimensionality.

are more scattered. These solutions, then, indicate that some of the categories – "jar", "bowl", and "plate" in particular – have relatively little featural variation among their members. "Bottle" appears to have a moderate level of variability. "Dish" and "container" have especially high variability with few shared features. The word "dish", for instance, is used by native speakers for objects including a butter dish, soap dish, casserole dish, baking dish, serving dish, and petrie dish (see the Appendix). It is unclear what characteristics these object might possess that either link them as cases of "dish" or separate them from cases of "bowl" or "plate". This word also can be used at varying levels of abstraction, with its use in a phrase such as "doing the dishes" including plates and bowls, and its use in phrases such as "baking dish" contrasting with "serving plate" and "mixing bowl". The word "container" is similar to "dish" in both regards. The typicality data in the current study appear to be sensitive to these variations in category complexity: learners are able to reproduce the native typicality gradients of "jar", "bowl", and "plate" fairly well even early in learning; they perform poorly on "bottle" initially but make substantial progress over time; and they, like the native speakers, find "dish" and "container" to be confusing categories without clear-cut typicality gradients.

Relation of age of acquisition to performance

To evaluate whether age of exposure to English has a relation to ability to master native naming, we correlated the age of beginning to learn English with the weighted naming scores reflecting match to native naming patterns. The correlation for the bottles stimulus set was $-.25$, $p < .025$ (one-tailed), and the correlation for the dishes stimulus set was $-.20$, $p = .05$ (one-tailed). The small but significant negative correlations indicate that participants who were younger at initial exposure to English tended to have higher matching scores. However, earlier acquisition will tend to be correlated with more years of formal instruction and more years of immersion. A multiple regression showed that, for both bottles and dishes, once the effects of years of immersion and years of formal instruction were removed, age of acquisition had no significant predictive value ($\beta = .092$, $p > .56$ for bottles; $\beta = .059$, $p > .73$ for dishes). Thus we find no evidence that age of initial exposure to English influenced the ultimate level of match to native speakers' naming patterns.

We also examined whether age of immersion in an English-language environment, as opposed to age of exposure per se, would predict weighted matching scores. Age of immersion correlated with performance $-.49$ for the bottles set, $p < .01$ and $-.25$ for the dishes set, $p < .05$, indicating that participants who were immersed at younger ages perform better than those immersed later. However, age of immersion was highly negatively correlated with years of immersion ($r = -.86$, $p < .001$), as must be expected given the restricted age range of the sample: Those immersed in an English-speaking environment earlier have also been immersed longer. A multiple regression showed that once the effect of years of immersion was removed, age of immersion had no significant predictive value ($\beta = -.11$, $p > .61$ for bottles; $\beta = .31$, $p > .20$ for dishes). The data thus do not provide evidence for an effect of age of immersion on performance, but because of the high correlation with years of immersion, we cannot fully assess the potential for an independent contribution.

Learner strategies for naming in English

To evaluate whether second language learners generate names for objects in English by trying to translate directly from the name they would have used in their native language, we examined two measures: the strategy reports participants gave at the end of each English naming session, and the relation between the names that individuals generated in English and the names they gave in their native language.

Table 6 gives the proportion of choices for the different strategies specified on the strategy questionnaire, for learners grouped by years of immersion. The most notable feature of the distribution of reports is that for both the dishes set and the bottles set, the proportion of choices indicating attempts at direct translation was relatively low, including for participants with the fewest years of immersion in an English speaking environment. Participants also rarely indicated that they were just guessing, including those at the lower levels of learning. The first option, indicating that a word "just felt right" and the third, indicating using particular features as criteria for applying particular words, dominated the strategy selection for all the levels of experience. The other major feature of the choice distribution is that there is an increase in the first choice ("just felt right") for those with the highest amount of experience with English, especially for the dishes set (and, for the dishes set, this increase is mirrored by a decrease in choices indicating use of specific features).

Thus the strategy report data suggest that participants, even those who are relatively inexperienced learners, are not primarily attempting direct translation from their native language to English in generating names for the objects. Rather, they draw on semantic information that they associate directly with the English words, either consciously (reflected in reports of using specific features) or unconsciously (reflected in reports that a word "just felt right"). As one might expect, the most experienced speakers of English appear to engage less in the conscious consideration of properties and more in the intuitive generation of words.

Table 6. *Strategy reports (given as percent of each choice) for learners grouped by years of immersion in an English-speaking environment.*

	Bottles Strategy report option					
Speaker group	Felt right	Equivalent to	Features present	Guessed	Other	No response
Less than 1 year	24	18	41	6	12	0
1 to 4 years	17	11	50	11	11	0
5 to 9 years	38	13	44	0	6	0
10 or more years	44	6	44	6	0	0
	Dishes[8] Strategy report option					
Speaker group	Felt right	Equivalent to	Features present	Guessed	Other	No response
Less than 1 year	15	15	46	15	0	8
1 to 4 years	25	8	58	8	0	0
5 to 9 years	33	8	50	0	8	0
10 or more years	62	8	15	15	0	0

"Felt right" = "Different names just 'felt right' for different objects"; "Equivalent to" = "I know [name] is equivalent to the word __ in my language"; "Features present" = "I called things [name] if they had the features __, __, __"; "Guessed" = "I didn't really know what the right name is; I had to guess or use a word I thought might be wrong"; "Other" = "Other strategy/strategies".

To look at the relation between the English names generated and native names, we first identified the categories of the native language that individual participants used (e.g., a person might have used one name for 10 objects, a second name for 15, a third for 6, etc.). We aligned these categories with those that the same participant produced in English to achieve the maximum possible overlap between the membership of the native categories and the membership of that person's English categories. For instance, if a native speaker of Spanish called more of the objects that she named "tarro" in Spanish by the name "jar" in English than by any other name, then "tarro" and "jar" were considered aligned. We then counted, for each participant, the number of objects having a category membership in English that did not match the membership in the native language. So, for instance, if "tarro" and "jar" were aligned for a speaker, any object named "tarro" in Spanish but receiving some name other than "jar" in English counted as a mismatch of membership.

Our data for this analysis were limited by the fact that many of our participants had native languages using writing systems other than the Roman alphabet (e.g., Bengali, Hindi, Korean, Japanese, Chinese). Some of the most experienced learners who had been away from their native environment for many years reported that they could no longer write in their native writing system and so did not complete this portion of the experiment. For those who did, in many cases it proved impossible to determine what elements of the responses were the head nouns and to pattern match across responses well enough (especially given the inherent noisiness of handwriting) to determine which were the same. We did, however, have sufficient analyzable data to compare a group of 8 highly experienced learners (defined by years of immersion; all had 10 or more years in an English speaking environment, with a mean of 15.25 years) with a group of 13 substantially less experienced learners (also defined by years of immersion; all had between 0 and 4 years in an English speaking environment, with a mean of 1.63 years). We assume that if a direct translation strategy is used, it will be used more heavily by those in earlier stages of learning, and so the less experienced group should show more reliance on (and hence a closer match to) their

[8] Seventeen participants were inadvertently given the strategy report sheet for bottles following their dishes naming. The data reported here eliminate responses for dishes from those participants. In most cases, the participants appear to have understood that they were supposed to be responding about dishes (e.g., they listed the features they used in calling objects "bowl", "dish", or "plate"; some even wrote in corrections on the sheet). If data from those participants are included, the pattern remains the same.

native categories than the more experienced group. This comparison showed slightly higher mismatch scores for the more experienced learners (with a mean of 26.6 for bottles and 31.0 for dishes) than for the less experienced learners (who had a mean of 24.7 for bottles and 25.8 for dishes). However, the small difference was not significant for either comparison, $t(18) = .53$ for bottles, $p = .6$; $t(19) = 1.52$, $p < .15$ for dishes. This outcome provides little support for the idea that the less experienced learners use direct translation in generating English names.

This outcome is consistent with the strategy reports given after each English naming session, which were collected from all participants. The two measures together suggest that the discrepancies from native patterns generated by the non-native speakers are caused by processes other than attempting to translate directly from a native word for an object to an English word.

General discussion

Summary

Second language learners with a relatively modest level of experience with English applied names to objects in patterns that diverge from native naming patterns, despite having substantial vocabularies overall and in our stimulus domain. They also showed a discrepancy from native typicality gradients for the major linguistic categories that native speakers use in naming the objects. As learning progressed, the ability to match the native distribution of names improved, as did agreement with native typicality judgments. However, even highly experienced learners of English – having had extensive formal instruction in English and having been immersed in an English-speaking environment for many years – remained significantly different from native speakers in their naming patterns, and, for some of the linguistic categories, divergent from native typicality judgments.

Consistent with the view that an important part of the learning process is acquiring extensive experience with the naming of individual objects, time spent immersed in an English-speaking environment was a better predictor of mastery of native naming than were years of formal instruction. Age of introduction to English was not a significant predictor of mastery, suggesting that exposure per se, not exposure during an early critical period, is the key to acquisition.

Strategy reports and an examination of the relation between the learner's native language naming patterns and English naming patterns suggest that deviations from native English patterns in the least experienced learners' data are not due to attempts to translate directly from the learner's own native language. All levels of learners, rather, appear to generate names by appealing to semantic information that they associate with the names, either consciously or unconsciously. The naming and typicality data indicate, however, that despite these strategies, the learners have in some way failed to learn exactly what to look for or to have the same intuitions as native speakers.

Note that the results on ability to match native naming cannot be due simply to more experienced learners of English knowing and using more words in our stimulus domains. The dominant names used by native speakers for the dishes stimulus set consisted of only three words: "dish", "bowl", and "plate". Non-native speakers could only reduce their score, not increase it, by using a larger variety of words. Likewise, the dominant names used by native speakers for the bottles stimulus set, for 54 of the 60 objects, were only three: "bottle", "jar", and "container". Non-native speakers would maximize their score for these 54 objects by using only these three names. Six of the objects did have other dominant names for the native speakers ("jug" for two objects; "can" for two, "box" and "tube" for one apiece); however, learners could improve their score using a greater variety of words only by using them for these six and no others. Further, in most of these cases the dominant name was not strongly dominant, yielding a low weight in our scoring system. The low weights and small number of items means that the contribution of these names to matching scores was small. The data from the most experienced learners of English also demonstrate that even for speakers with extensive English vocabularies and high levels of self-rated proficiency, discrepancies between the naming patterns of non-natives and natives remain.

How does incomplete lexical knowledge affect second language naming and typicality judgments?

Kroll and colleagues (e.g., Kroll and Curley, 1988; Kroll and Stewart, 1994) have suggested that for beginning second language learners, access to words in the second language lexicon is mediated by words of the first language. For instance, a Spanish speaker learning English who is presented with a container to label would access stored conceptual knowledge about that object. Accessing that knowledge would activate a Spanish name such as "botella", and the Spanish name would then activate a linked English word such as "bottle". For learners at this stage of acquisition, an account of the impact of an incomplete lexical knowledge base on second language naming is straightforward. The word chosen will be determined by the links established between first and second language words. Because those links do not accommodate any discrepancies in the distributions of the words between languages, the second language use of any given word will simply follow the first language distribution of the linked word. Graham and Belnap (1986) provide evidence of such a pattern for native speakers of Spanish in early stages of learning English.

Kroll's data indicate, however, that as proficiency increases, links are built from conceptual knowledge directly to words in the second language lexicon so that mediation by the first language vocabulary is no longer needed. As discussed earlier, even our least experienced learner groups were not beginners in English. They were no longer studying English in a classroom but rather were immersed in an English-speaking environment and were using English in their daily activities. Thus they are likely to have progressed to the stage where direct links between knowledge about objects and English words are being built. Indeed, the strategy reports and measure of match to participants' own native naming argue against a direct mapping strategy for our sample, including the least experienced learners. The discrepancy from native patterns that our participants at the lower levels of experience showed may thus be a more direct consequence of the incomplete knowledge base: learners activate names directly from their conceptual representations, but because there are many language-idiosyncratic object–name pairings that they have not been exposed to yet and for which appropriate object–name links have not been built, they may generate incorrect labels by attempting to generalize from a limited number of known object–label pairings.

If lack of knowledge of the word uses were the only factor hindering our learners' performances, one might expect that the most experienced learners, who have been in an English-speaking environment for ten or more years, would have acquired enough information to match the native patterns. The fact that naming patterns remained distinguishable from those of native speakers even for the most experienced learners suggests that there may be other ways in which the differences between the learners' native naming patterns and the to-be-learned patterns affect their performance.[9]

One way is that second language learners may not simply be building links to the second language lexicon from a *tabula rasa* starting point as a young native learner would be. They may initially import the pattern of links from objects to words that their native language uses and thus experience interference from the imported pattern in the process of acquiring the new pattern (as first language syntax appears to interfere with learning second language syntax; see, e.g., MacWhinney, 1992; Tao and Healy et al., 1998; see also Jiang, 2000, for discussion of the lexical level from a slightly different perspective). Learners must not only acquire new links but unlearn the original ones,[10] which may be difficult to do (e.g., Barnes and Underwood, 1959). In addition, Kroll (e.g., Kroll, 1993; Jared and Kroll, 2001) suggests that links between the native and second language lexicons may be retained even as links are built directly from conceptual knowledge to the second language lexicon, with the result that native language vocabulary may be activated along with second language words under some circumstances. This possibility suggests that when the pattern of object-name links is not parallel in the two languages, an object might activate a second language name and, through its link to a native word, also activate a different second language name that competes with the first and reduces the correspondence of names produced to those that would be used by native speakers. Thus the second language learner is at a disadvantage both in establishing the native pattern of object-name links and in selecting the native name choice upon seeing an object, relative to a young native learner.

A second factor that may contribute to the persistence of some degree of error is mature learners' sophisticated ability to use contextual information in communication. As MacWhinney (1992) points out in discussing why second language learners may not achieve fully native syntax and phonology, mature learners can often use context to understand sentences without paying attention to details of form and without noting discrepancies from their own implicit version of the same material. They may tend to do so more than young native learners do (see also Newport's, 1990, "less is more" hypothesis and Cochran, McDonald and Parault, 1999). In parallel, in production, it is rare that communication between adults is hindered by minor discrepancies in syntax or phonology. The same would seem to be true for the names applied to objects. If the object is physically present, the intended referent is often obvious regardless of what name is applied. If it is not present, the speaker and addressee may never become aware if there is a slight discrepancy between what the speaker has in mind and what the addressee takes to be the referent. Thus both in production and comprehension, whether the referent is present or absent, some discrepancies from native understanding of the distribution of a word may go unnoticed. Communication

[9] Our native speakers, approximately 18–21 years old, did have somewhat more years of exposure to English than the most experienced learners, whose years of immersion ranged from 10 to 19. One might suggest, then, that the difference is still due to the difference in years of exposure. However, the most experienced learners who had 15–19 years of immersion (8 participants) scored at the same level (.52 for the bottles set and .39 for the dishes set) as this group as a whole (.53 for bottles and .42 for dishes). Further, years of immersion within the more experienced group did not have a positive relation to scores ($r = -.22$ for bottles, n.s., and $r = -.55$ for dishes, $p < .025$). Thus it is unlikely that the discrepancies are due simply to fewer years of exposure for the learners.

[10] MacWhinney (1992) suggests that "fossilization" of native patterns may occur through increased automatization of the first language system with increasing age. This notion suggests that age of immersion may be an important variable in determining ultimate mastery, although we were unable to test this possibility well because age of immersion is so closely related to years of immersion in our sample.

needs may push learners to reach a certain level of knowledge, but there may be little miscommunication feedback pushing them farther.

Finally, many second language learners continue to use their native language with family and friends even when living in the second language environment, as about half of our participants indicated that they do. This fact will keep links from objects to native names active and more likely to interfere with second language naming than if the native language were left unused. In addition, even when learners are using the second language, their conversational partners frequently may not be native speakers of the language themselves, and so non-native patterns may be reinforced.

The discussion thus far has centered on naming choices, but our data indicate that typicality judgments also remain distinct from native judgments for some of the lexical categories. This result follows naturally from the possibility that object–name links are not fully native-like. Objects are presumably judged typical of their linguistic category to the extent that the link between the object and the name is strong and the object shares many features of other entities to which that name is also linked. If the strength and pattern of object–name links deviate from those of native speakers, then typicality judgments will also diverge. The fact that our learners showed more divergence for some categories than for others may be a function of how intrinsically difficult the categories are to master (that is, of how featurally diverse the membership is), as already noted. If our suggestion that native naming patterns are imported as a starting point is right, a second contributor may be how much the categories resemble those of other languages and thereby the native categories of each learner. (See Malt et al., in press, for evidence that some of the lexical categories of the bottles stimulus set are more closely shared across English, Spanish, and Chinese than others are; see Aitchison, 1994, for a brief report suggesting an enduring influence of native object–name links on second language typicality judgments).

Implications for models of second language lexical development

The simplest version of how conceptual knowledge might be represented in models of the bilingual lexicon is in terms of nodes, with each node representing a concept (which is then linked to a word in the native language and ultimately to one in the second language). However, the observation that roughly comparable words are not necessarily equivalent across languages dictates that a complete model must unpack conceptual knowledge, so that some of the knowledge associated with a word in one language can differ from that associated with the most closely comparable word in another language. De Groot (1992, 1993) suggests that, especially for abstract words, one should conceive of a word meaning as a composite of elements that are not always fully shared between a pair of translated words.

We suggest that a more radical approach than De Groot's is needed on two fronts. First, our data (Malt et al., 1999; Malt et al., in press, and the current results), along with Kronenfeld et al.'s (1985) data on drinking vessels and the more anecdotal observations cited earlier, indicate that the need to unpack the conceptual representation is not limited to abstract words but applies to concrete nouns referring to common, everyday objects as well. This view is further reinforced by the issue of polysemy for concrete nouns. Although the applications of "bottle", "jar", etc. to various objects in our stimulus set may not be different enough to say that these uses correspond to distinct senses of the words, many concrete nouns do have uses divergent enough that they are considered to reflect different senses. And the different senses will not necessarily be shared across languages, even if the central sense is comparable. For instance, in English we speak of a human foot, an animal foot, the foot of a bed and of a table, a foot soldier, and so on. In Spanish, "el pie" is used for a human foot, but "la pata" is used for a (non-human) animal foot. The end of a bed or table is "el extremo", and a foot soldier is a "soldado de infanteria". Thus differences between languages in the knowledge associated with roughly comparable words are likely to be pervasive even for common, concrete nouns (see also Pavlenko, 1999). We propose that for ALL nouns (as well as other parts of speech such as prepositions, e.g., Bowerman, 1996, and verbs, e.g., Talmy, 1985), models must accommodate the fact that roughly equivalent words in two languages will not necessarily fully share conceptual representations.

Second, it is not merely "elements of meaning" that can be shared or not shared by roughly comparable words in different languages. The "elements of meaning" notion suggests that the knowledge associated with a word can be captured in a single summary representation, albeit one in which different elements are specified. Our view implies that the knowledge that allows native-like use of a given word cannot be captured by a summary representation. Some object names are not fully predicted by their properties; rather, they are consequences of historical linguistic and cultural forces that are not necessarily transparent even to native speakers of the language. In such cases, only knowledge of specific object–name conventions will allow native-like labeling of the objects. The case of polysemy again bolsters this argument. The differences between Spanish and English in the uses of "foot" versus "pie" are not predictable from an understanding of the most literal or central uses of the words. The proper uses in each language can only be generated (in part) by additional knowledge about the individual cases. (Indeed, the different senses of polysemous words may be represented

separately in memory rather than captured in a summary representation; Klein and Murphy, 2001, 2002). Thus we suggest that a complete model of bilingual lexical knowledge will require substantial information about individual uses along with any explicitly represented featural or summary information.

The argument that the bilingual lexicon must incorporate two different sets of links from words to knowledge about objects raises the question of whether the linking patterns influence each other. For instance, we have already suggested that the first language pattern may be initially imported into the second language. As the second language linking pattern becomes more native-like, if the second language becomes the dominant one, is there a backward influence in which the first language links shift to be more like the second language pattern? And for balanced bilinguals, raised hearing native speech from two languages, will two separate and native-like sets of links be established, or will there be a mutual influence such that neither is fully native-like (as has been suggested for phonology, for instance; see, e.g., Singleton, 2001)? If there is evidence for such influences, a challenge for developing models will be how best to capture them to enable predictions about performance.

Implications for second language teaching

Finally, our consideration of the reasons that second language learners may deviate from native naming patterns suggests several avenues for improving mastery of naming patterns. It may be inevitable that beginning language instruction will use paired-associate learning of rough translational equivalents as a major means of providing vocabulary information; this is an efficient way of conveying information that allows the beginner to use a word in approximately the right way. However, providing some explicit metaknowledge to students about the potential for discrepancies between languages may help sensitize them to the need to pay attention to where uses diverge. To the extent that maintaining versus overriding the imported mappings has a voluntary aspect, awareness of the potential for differences may also speed overriding of the inappropriate links. Most importantly, the input needed to master the patterns can only come from extensive observation of object–word pairings, and this sort of observation will come best through immersion in the second language environment (see also Pavlenko, 1999; Jiang, 2000; Dewaele and Regan, 2001; and studies of mastery of morpholexical variables such as gender agreement, e.g., Dewaele and Veronique, 2001). In the absence of study abroad or other immersion opportunities, learning might be enhanced in the classroom by focusing less on reading books (in which the language alone, without corresponding visual input is provided) and more on films, plays, and interactive activities in which students observe real-world referents of the words spoken.

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Received July 16, 2002 Revision accepted December 16, 2002

Appendix

Note. The following are informal descriptions of the objects in the stimulus sets. These descriptions are intended only to give a general sense of the objects in the set and do not necessarily include all features that participants may have considered relevant to name choice or typicality. The head noun in each description is the one most frequently used for the object by the native speakers. Comparative adjectives such as "tall" or "fat" are relative to other objects receiving the same name in the stimulus set. Descriptors other than the container name (and, for the bottles set, contents) are included only where needed to convey central properties of an object that would not be readily inferred.

Bottles stimulus set

1. small plastic lip balm container; screw-on lid
2. plastic 35 mm film container
3. small glass medicine bottle with dropper top
4. plastic vitamin bottle; narrow neck, wide mouth
5. small plastic ibuprofren bottle; wide mouth
6. small plastic spice container; wide mouth
7. small glass crushed garlic jar
8. small plastic iodine bottle; rectangular body, cylindrical neck
9. tall plastic spice container; narrow neck, wide mouth
10. tall glass spice jar; graduated
11. olive jar
12. glass baby fruit juice jar
13. spicy mustard jar, graduated
14. maraschino cherry jar
15. baby applesauce jar
16. roll-on deodorant container
17. small instant coffee jar
18. butterscotch sauce jar; graduated
19. salsa jar
20. squeeze tube; petroleum jelly
21. baby lotion bottle; large spherical top with baby face
22. plastic foot powder container; shaker top
23. plastic insect repellent can; pump top with lid
24. metal insect repellent can; spray top
25. rectangular plastic hand lotion container; pump top
26. metal belt cleaner can; screw top
27. grape jelly jar
28. plastic squeeze bottle; spicy mustard, squirt top
29. plastic peanut butter jar; squat
30. glass popcorn jar
31. glass honey jar; fat body, narrowed neck
32. child's cardboard juice box
33. plastic squeeze bottle; grape jam
34. glass mayonnaise jar
35. plastic kitchen cleanser; shaker top with lid
36. tall plastic peanut butter jar
37. glass applesauce jar; narrowed neck
38. glass spaghetti sauce jar; narrowed neck
39. rectangular plastic baby powder container; shaker top
40. annular-shaped baby bottle
41. open cylindrical plastic baby bottle; plastic liner
42. glass maple syrup bottle; fat body, very narrow neck, handle

43. large plastic windshield washer jug; narrow neck, handle
44. tall dry roasted peanuts jar
45. square plastic marinara sauce container; lid
46. cardboard frozen orange juice can
47. metal compressed air can; spray top
48. graduated plastic body powder; shaker top
49. plastic sports bottle; large, cylindrical, wide mouth with straw in lid, handle
50. glass juice bottle
51. rectangular plastic shampoo bottle; flip top
52. small plastic bath foam container; flattened in depth
53. round cardboard salt container; pour top
54. large plastic corn oil jug; handle, small mouth
55. plastic dish detergent bottle; hourglass shape, squirt top
56. plastic spray cleaner bottle; curved upper portion with pump
57. large plastic laundry detergent bottle; handle, pour top
58. large plastic soy sauce container; flattened in depth, handle and pour spout on top
59. large plastic sodium sulfite container; wide mouth, inset handles
60. large plastic milk jug; small mouth, handle

Dishes stimulus set

1. small wooden salad bowl; flat bottom, vertical sides
2. small decorative bowl; pedestal base
3. child's plate; wide beaded rim enclosing miniature toys
4. small decorative ceramic bowl; shallow
5. glass mixing bowl; deep, small handles
6. cut-glass serving bowl
7. small decorative ceramic bowl; deep
8. divided serving dish; shallow
9. plastic Tupperware storage bowl; handles
10. plastic cat food bowl; flat bottom, wide base
11. oval ceramic soap dish; ridged bottom
12. divided glass candy dish; octagonal, shallow
13. ceramic fish-shaped bowl
14. metal candy bowl; pedestal base
15. plastic mixing bowl; deep
16. small cut-glass sugar dish; handles
17. large wooden salad bowl
18. child's plastic "sippy" bowl; straw built in
19. decorative glass dish; two sides raised with handles
20. decorative bowl made of interlocking duck shapes; pedestal base
21. ceramic cat food bowl; flat bottom, vertical sides
22. large decorative bowl; tall pedestal base
23. covered shallow bowl, upper sides slope inward
24. Corningware bowl; handles
25. octagonal glass cereal bowl
26. glass plate with plastic lid; deep
27. dinner plate
28. plastic rectangular soap dish with lid
29. glass leaf-shaped candy dish
30. small ceramic bowl; lid and handle
31. round pyrex casserole dish with lid
32. small class candy dish on pedestal with lid
33. small glass bowl; wide rim
34. honey bowl (pot); straight sides, lid with handle and opening for serving tool
35. plastic butter dish with cover
36. oval glass casserole dish; lid with handle
37. petrie dish with lid
38. rectangular glass baking dish in insulated basket
39. cut-glass candy dish on pedestal; lid with handle
40. square shallow Corningware serving/baking dish with handles; plastic lid
41. round Corningware baking dish; vertical sides, lid with handle
42. shallow wooden bowl; giraffe-head handles set in inside
43. painted wooden plate; deep

44. decorative ceramic candy dish on pedestal; handles
45. glass pie/quiche dish
46. decorative ceramic serving dish; handles, shallow
47. small divided glass pickle dish; handles
48. small decorative plate (saucer)
49. large decorative ceramic plate; deep
50. glass butter dish; handles
51. child's decorative plastic plate; small
52. metal camp plate with wide rim; deep
53. baby's divided plastic plate, deep; set into warming device
54. decorative ceramic dinner plate
55. disposable plastic plate
56. small fluted glass dish; handle in center
57. small crystal serving plate
58. divided plastic plate
59. fish-shaped serving dish/plate
60. decorative fluted ceramic plate; octagonal