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How bilinguals solve the naming problem ☆

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Abstract

If different languages map words onto referents in different ways, bilinguals must either (a) learn and maintain separate mappings for their two languages or (b) merge them and not be fully native-like in either. We replicated and extended past findings of cross-linguistic differences in word-to-referent mappings for common household objects using Belgian monolingual speakers of Dutch and French. We then examined word-to-referent mappings in Dutch–French bilinguals by comparing the way they named in their two languages. We found that the French and Dutch bilingual naming patterns converged on a common naming pattern, with only minor deviations. Through the mutual influence of the two languages, the category boundaries in each language move towards one another and hence diverge from the boundaries used by the native speakers of either language. Implications for the organization of the bilingual lexicon are discussed.

Keywords: Bilingualism; Lexical organization; Similarities and differences in artifact categorization

Introduction

Similarity as a basis for linguistic categorization

Many prominent models of categorization assume that similarity is the basis of categorization: Objects will tend to share names in proportion to their shared properties and in inverse proportion to the object's similarity to objects with different labels (Ashby & Maddox, 1992; Kruschke, 1992; Medin & Schaffer, 1978; Nosofsky, 1984, 1986; Rosch & Mervis, 1975). If perception of properties is shared across cultures, these models suggest that speakers of all languages will segment the world by name in similar ways.

However, recent cross-linguistic comparisons of the sets of objects or things to which category names refer have revealed substantial differences in the way that speakers of different languages segment stimulus space by name. Such differences arise not only in naming of abstract or socially constructed domains such as kin or emotion but even for concrete nouns referring to common objects, which one might expect to correspond closely across languages (e.g., De Groot, 1993; Kroll, 1993). For example, the linguistic boundary between

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chair and *sofa* is not the same in Chinese as in English. In English, a large stuffed seat for one person is given the same label as a wooden chair, but Chinese speakers give the stuffed one the same label that they would give a stuffed multi-person seat—what English speakers call *sofa* (Malt, Sloman, & Gennari, 2003). Kronenfeld, Armstrong, and Wilmoth (1985) found that speakers of English, Hebrew, and Japanese grouped 11 drinking vessels by name in different ways. For instance, the Americans gave the same name to a paper drinking vessel and a vessel for drinking tea (calling both *cup*), while the Israelis did not. Malt, Sloman, Gennari, Shi, and Wang (1999) examined naming for a set of 60 common containers (mostly called *bottle* or *jar* in English) by speakers of American English, Mandarin Chinese, and Argentinean Spanish found substantial differences in the linguistic category extensions across speakers of the three languages. For the 15 objects named *container* in English, four different names were used in Chinese, and the Spanish category that contained the 19 objects called *jar* in English also included six objects called *bottle* in English and three called *container*. Malt et al. (2003) examined in more detail the relation among the linguistic categories for the 60 containers and found a complex pattern. Some of the categories were very similar across the three languages but some categories of one language were nested within those of another, and others showed cross-cutting in which pairs of objects put into a single category by one language were put into different categories by another language.

Dissociation between naming and similarity

Given the cross-linguistic differences in linguistic category boundaries, if a close connection exists between categorization and similarity (Kruschke, 1992; Medin & Schaffer, 1978; Nosofsky, 1984, 1986; Rosch & Mervis, 1975), then one must expect differences across speakers of different languages in what they know or understand about the objects. However, Malt et al. (1999) found that although the naming patterns diverged across speakers of the different languages, similarities among the objects were perceived in much the same way. Likewise, Kronenfeld et al. (1985) found comparable similarity judgments for the drinking vessels for their speakers of Hebrew, English, and Japanese. Hence, the perception of objects' similarities—and so the way that people conceptualize the objects non-linguistically—may be largely universal, while naming of objects—and so the way that people categorize them linguistically—is language-specific. Based on the dissociation of naming and similarity, Malt et al. concluded that naming cannot be driven only by featural commonalities that speakers perceive among objects. Other constraints on name choice that have evolved over the course of the language's history (such as convention, pre-emption, and chaining; see General discussion) must contribute to the naming patterns of each language. To understand how monolinguals speakers of a language link their knowledge of words to knowledge of the world, then, a distinction must be made between lexical concepts, which may be language-specific, and general non-linguistic understanding of the world, which may be universal (Levelt, Roelofs, & Meyer, 1999; see also Bierwisch & Schreuder, 1992; Levinson, 1997).

Cross-linguistic diversity and the challenge of bilingualism

The dissociation of naming from similarity and the differing patterns of naming across languages create a dilemma for speakers of more than one language. For those who acquire one language as their native language and later learn a second language, the naming patterns of the first language are presumably mastered; the problem to be surmounted is how to then acquire a different naming pattern that is associated with the second language. Malt and Sloman (2003) found that second language learners of English from a variety of first-language backgrounds had substantial difficulty with this task; they showed discrepancies from native speakers in their English naming patterns even after many years of immersion in an English-language environment. The difficulty posed to those who grow up exposed to two languages from birth is perhaps even greater. To be completely native-like in both languages, the child learner must attend to the distinctions between the two languages' naming patterns, acquire both patterns, and maintain them as distinct over time.

But evidence suggests that the two lexicons of proficient bilinguals are not isolated from one another. For instance, Schwanenflugel and Rey (1986) found cross-language semantic priming effects in a lexical decision task with Spanish–English bilinguals. Recognition of words in one language following other-language primes was as fast as that following same-language primes. Similarly, Guttentag, Haith, Goodman, and Hauch (1984) found comparable facilitation for item categorization when the target words were surrounded by unattended words highly related to the category regardless of whether the two words were within-language or across-language. Other cross-language semantic priming studies (e.g., Altarriba, 1992; Chen & Ng, 1989; Kroll & Curley, 1988; Williams, 1994) as well as evidence from picture naming and translation tasks (Potter, So, Von Eckhardt, & Feldman, 1984), word and picture identification and classification (Shanon, 1982), and word association and lexical decision tasks (Van Hell & Dijkstra, 2002), support the notion that the two lexicons of proficient bilinguals are interconnected (see also Francis,

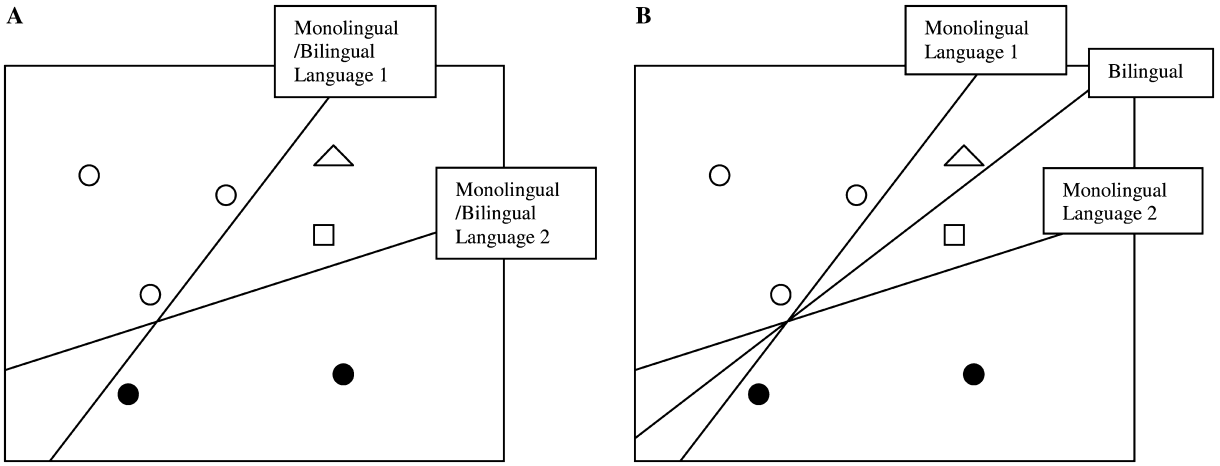

Fig. 1. Schematic representation of the two-pattern hypothesis (A) and the one-pattern hypothesis (B).

1999; Kroll & Sholl, 1992).[1] Recent evidence also indicates that there is cross-talk between the syntaxes of the two languages of the bilingual (e.g., Dussias, 2001, 2003; Hartsuiker, Pickering, & Veltkamp, 2004), and some cross-language contamination of phonology as well (e.g., Bullock & Gerfen, 2004; Kehoe, Lleó, & Rakow, 2004). Thus, the representations of the bilingual's two languages may be readily and broadly permeated by one another. If the mental lexicons of the bilingual's two languages have direct interconnections or indirect feedback loops involving links between word forms and representations of referents, it may be difficult or impossible for bilinguals to maintain two separate and distinct patterns of mappings from word forms to referents.

The present study was designed to address the issue of how linguistic diversity in naming patterns affects the bilingual lexicon. Specifically, we investigated the relation between bilinguals' two naming patterns and the relation of their two patterns to the corresponding monolingual naming patterns. The study was carried out in Belgium, a bilingual country where French- and Dutch-speaking monolinguals live alongside bilinguals who are brought up learning French and Dutch simultaneously. This situation provides an ideal laboratory in which to address these questions. We studied compound bilinguals having a French-speaking (monolingual) mother and a Dutch-speaking (monolingual) father or vice versa. Compound bilinguals learn and use their languages interchangeably in the same environment and in the same situations. Compound bilinguals are to be distinguished from coordinate bilinguals, who acquire and use their languages in strictly distinct environments, and from subordinative bilinguals, who learn the second language as a foreign language (i.e., are first exposed to it later in life) (Ervin & Osgood, 1954; see also Weinreich, 1953).

The one-pattern hypothesis vs. the two-pattern hypothesis

If different languages with different histories maintain different naming patterns, what does a bilingual, acquiring two different languages simultaneously, learn about how to name objects? Two contrasting hypotheses are suggested, presented schematically in Fig. 1. The geometric figures (circles, squares, and triangles) represent objects being named in Language 1 (L1) and Language 2 (L2). Monolingual speakers of L1 name the square and the triangle in the same way as the black circles, whereas monolingual speakers of L2 name them in the same way as the white circles. The first hypothesis, which we will call the *two-pattern hypothesis*, states that bilinguals acquire and maintain two distinct sets of connections of word forms to their referents. For each language separately, the naming pattern parallels that of the corresponding monolinguals. In Fig. 1A, this is represented by the overlapping linguistic boundaries of monolinguals and bilinguals in L1 and L2, implying that in L1, bilinguals put the square and the triangle with the black circles (i.e., analogous to the monolinguals of L1), whereas in L2, they put them with the white circles (i.e., analogous to the monolinguals of L2). The two-pattern hypothesis assumes no interactions, connections, or

[1] The classic Revised Hierarchical Model of bilingual lexical knowledge (Kroll & Stewart, 1994) assumes that such effects arise because word forms are connected directly to a shared conceptual space in proficient bilinguals. However, the differing naming patterns of different languages, along with the dissociation of naming from similarity and the consequent need to distinguish lexical knowledge from general non-linguistic concepts, indicates that the nature of the interconnections must be slightly more complex, with lexical knowledge intervening between word forms and the shared non-linguistic conceptual space.

feedback loops between the two languages of bilinguals. It thus predicts that the French and Dutch naming patterns will parallel the naming patterns of, respectively, the French-speaking monolinguals and the Dutch-speaking monolinguals. This representation of the bilingual lexicon requires substantial memory capacity, since two different mappings from word forms onto objects need to be stored separately. However, for bilinguals to demonstrate full native proficiency in each language, these separate mappings must be maintained.

The second hypothesis, which we will call the *one-pattern hypothesis*, assumes that through the simultaneous exposure to the two languages, bilinguals develop direct inter-connections or indirect feedback loops between the word forms of the two languages. At the same time, connections are developed from the word forms in each language to knowledge about referents. The continuous interaction between the two languages combines elements of the lexical concepts from both languages, so that the bilingual's semantic knowledge deviates from that of both monolingual groups. Consequently, the connections between the word forms and the associated extensions in the two languages are tuned to one another. The two naming patterns merge into one naming pattern that differs from either monolingual naming pattern. This is represented in Fig. 1B by the single linguistic boundary of bilinguals, situated between the linguistic boundaries of monolingual speakers of L1 and L2. The bilinguals segment the stimulus space in a way different from both monolingual language groups: the square is put with the black circles, the triangle with the white circles. The resultant naming pattern can be considered as a compromise that is reached between the two languages in which differences in naming patterns between the languages are smoothed out. Depending on the relative influence of the languages, the merged naming pattern can take different forms, varying from largely dominated by one language to a balanced situation in which both languages carry equal weight in determining the naming pattern, to largely dominated by the other language. The one-pattern hypothesis predicts that the bilinguals use a single naming pattern both for the French and the Dutch naming, and that it will differ from the corresponding monolingual naming patterns. In comparison to the two-pattern hypothesis, a merged pattern is more cognitively economical, since storing only one set of connections between word forms and referents is less demanding on the limited resources of permanent memory. However, it means that bilinguals will not show fully native-like naming performance in one or both of their languages.

The hypotheses just outlined occupy two extreme positions along the continuum of possible bilingual lexical organization. However, the truth may also be situated somewhere in between: the two naming patterns of bilinguals may converge toward one common naming pattern but not match perfectly. To take such an intermediate possibility into account, we consider a weaker version of the one-pattern hypothesis later.

Goals

In the study presented below, we collected naming data and similarity judgments for ordinary household objects for French-speaking monolinguals, Dutch-speaking monolinguals and French-Dutch bilinguals. We address two questions. The main question is how and to what extent the French and Dutch bilingual naming patterns are related to each other and to the corresponding monolingual patterns. Before addressing this main question, we ask whether the dissociation of naming and similarity found by Malt et al. (1999) can be replicated with French- and Dutch-speaking monolingual Belgians.

The replication study was carried out for two reasons. First, it is only informative to test the bilinguals and compare them with the monolinguals if the Dutch- and French-speaking monolinguals show the same pattern of results as described in Malt et al. (1999), i.e., different naming patterns and a similar perception of commonalities among objects. Second, replicating the study of Malt et al. in Belgium provides us with an opportunity to extend their results with several improvements in methodology, allowing us to disentangle the influences of different factors on naming patterns. The different language groups we studied share largely the same current culture. Malt et al., on the other hand, studied speakers of languages originating on three different continents with substantially different modern cultures as well as linguistic histories. If Belgian speakers of French and Dutch—for whom current cultural differences are essentially absent—likewise show different linguistic segmentation but a common perception of similarity among objects, this result will indicate that languages' differing histories have powerful and lasting effects on the naming patterns at a later time. Second, since the objects we used are found throughout the country, all three samples of participants (Dutch- and French-speaking monolinguals and bilinguals) are equally familiar with the stimulus set. Malt et al. used American stimulus materials in their study, which are most familiar to American participants. The equal familiarity of all participants with the items allows us to disentangle the influence of linguistic histories on naming patterns from any effect of item familiarity.

Method

Participants

Monolingual participants for both naming and similarity sorting were 32 native speakers of Dutch, all

students or research assistants at the Psychology Department of the Leuven University, and 29 native speakers of French, students at the Psychology Department of the University of Liège. The monolingual participants did have some knowledge of the other language through limited formal instruction at school. However, none of them but three used the other language in his or her daily activities (three Dutch-speaking monolinguals sometimes used French at work) and none of them considered himself or herself proficient in it, as derived from a proficiency estimation used to determine the participants' knowledge of the non-native language (see Materials). Belgian students also typically have exposure in school to English instruction between the ages of about 14 and 18, but these monolinguals did not regularly use any language other than their native tongue. The monolinguals performed the naming and sorting task once each, except for five participants of the Dutch-speaking group who were retested for naming, to check for within-subject reliability. The time span between the test and the retest was approximately 6 months.

The bilingual participants consisted of 25 people having a Dutch-speaking father and a French-speaking mother (14 out of 25) or vice versa (11 out of 25) and who had been raised speaking both languages by virtue of each parent consistently speaking their own language to them from childhood onward. All of the participants were students (except one, who was a research assistant) at the universities of Leuven, Brussels or Louvain-la-Neuve. As with the monolinguals, they would have had some exposure to English language instruction in school between 14 and 18 years, but they did not regularly use languages other than Dutch and French. The bilingual participants performed the naming task twice immediately after one another (once in French and once in Dutch) and the sorting task once. They also completed a language history questionnaire, used to determine the participants' language background. Five bilinguals renamed the objects in French and five other bilinguals renamed the objects in Dutch after a time span of about 6 months.

The Dutch- and French-speaking monolingual participants received course credit or participated as unpaid volunteers. The bilinguals were paid for their participation.

Materials

There were two sets of stimuli, one consisting of 73 pictures of storage containers (similar to the stimuli in Malt et al.'s (1999) study), the other consisting of 67 pictures of cups and dishes for preparing food and serving food and drink (similar to those in Malt & Sloman, 2003). The objects of the first set, which we will call the "bottles set," 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. Translated into Dutch and French, the objects are likely to be called *fles* or *bus* and *bouteille* or *flacon*, respectively. It should be noted that the roughly equivalent terms are not necessarily true translation equivalents, nor do they necessarily encompass the same group of referents; the data will confirm that they are not fully equivalent. For the second set, which we will call the "dishes set," objects were selected to be likely to be called *dish*, *plate*, or *bowl* in American English. In Dutch, the objects are mostly called *bord*, *schaal*, or *kom*, and in French, *assiette*, *plat*, or *bol*. Again, the roughly corresponding names are not assumed to be perfect translation equivalents.

The objects were all found at home, work, or in stores frequented by the researchers. For both sets, we made an effort to include objects that represented the full variability that exists within each domain. The wide range of objects allows a sensitive comparison of the naming patterns of the three groups of participants.

All objects were photographed in color against a neutral background with a constant camera distance to preserve relative size. A ruler was included in front of each object to provide additional size information. Because the labels on the objects of the bottles set were generally in both Dutch and French, no additional information about the nature of the object contents (e.g., ketchup) was necessary. Some of the pictures used in the experiment are shown in Figs. 2 and 3.

A questionnaire was used to determine the language background of the bilingual participants. Questions were asked about age and sex, where the participant was raised, what language her mother and father speak, what language she speaks with her mother and with her father and whether she usually speaks only one language (Dutch or French) with her mother and the other with her father, what language was used at primary and secondary school and during leisure activities, which language she currently uses most, in which of the two languages she believes she spontaneously thinks, and estimated proficiency for the two languages. Following the same procedure as Malt and Sloman (2003), proficiency estimates were obtained by asking the participants to circle a number for each language between 1 ('not at all proficient: you can barely speak the language') and 7 ('very proficient: you can speak the language like a native speaker'). Other studies have shown that similar self-report measures correspond well with performance measures of proficiency such as reaction time on a verbal categorization task (Dufour & Kroll, 1995; Kroll, Michael, Tokowicz, & Dufour, 2002). The mean estimations for the two languages were very high: 5.7 for French (*SD* of 0.64) and 6.5 for Dutch (*SD* of 0.74).

The same proficiency estimates were gathered for the non-native language of the monolinguals, with a mean

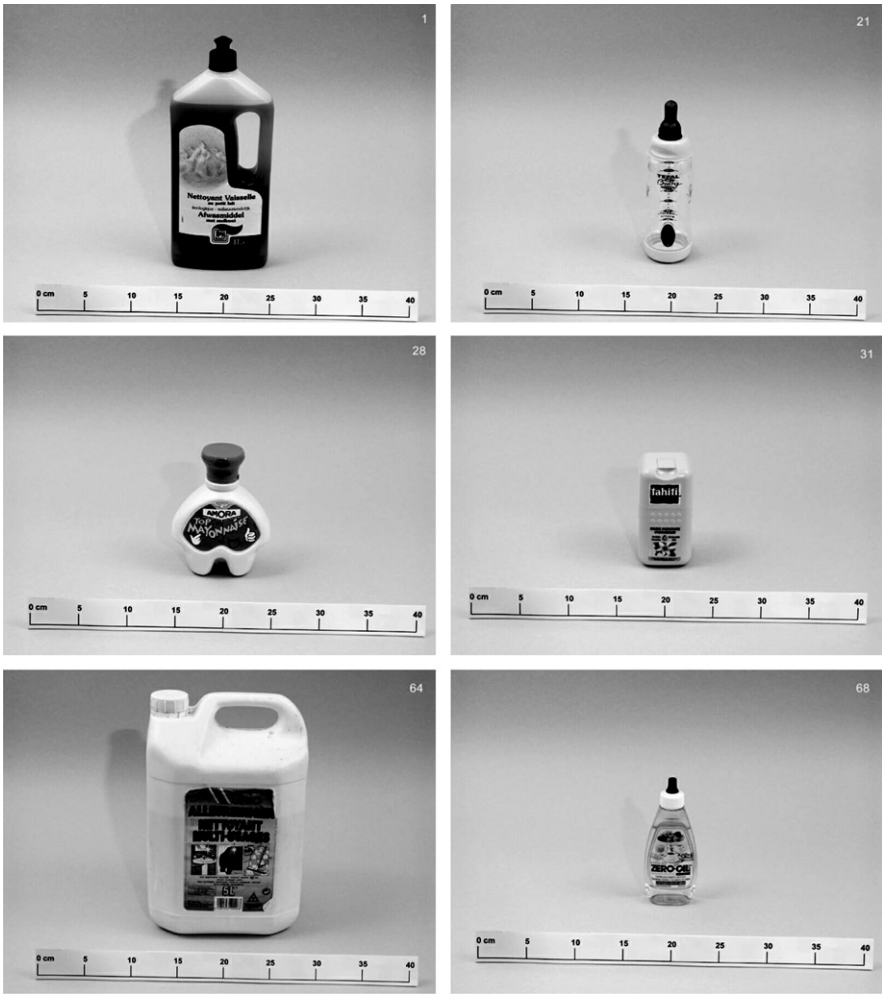

Fig. 2. Some of the exemplars of the bottles set used in the experiment.

estimation of 2.8 for the French competence of Dutch-speaking monolinguals (*SD* of 0.83) and 1.3 for the Dutch competence of French-speaking monolinguals (*SD* of 0.65).

Procedure

The naming and sorting tasks were performed in one experimental session. In the naming task, participants were first asked to look through the pictures in each set to familiarize themselves with the variety of objects in each set, and then they were asked to name each object. They were instructed in the language in which the task was performed: Dutch for the Dutch-speaking monolinguals and for the bilinguals in the Dutch naming task, French for the French-speaking monolinguals and for the bilinguals in the French naming task. The instructions were the same as in the naming task of Malt et al. (1999): participants were asked to give whatever name seemed like the best or most natural name, and they were told that they could give either a single-word name or a name with more than one word. The instructions emphasized that participants should name the object itself and not what it contained. Each participant first named all the objects of one set (the bottles set or dishes set) and then all the objects of the other set. The order of the two sets was counterbalanced. Since bilinguals named the objects twice, the order of languages was also counterbalanced, to control for any order effect. Between the Dutch and the French version of the naming task, the pictures were shuffled.

After participants completed the naming task (once for the Dutch- and French-speaking monolingual participants, twice for the bilinguals), the pictures were again

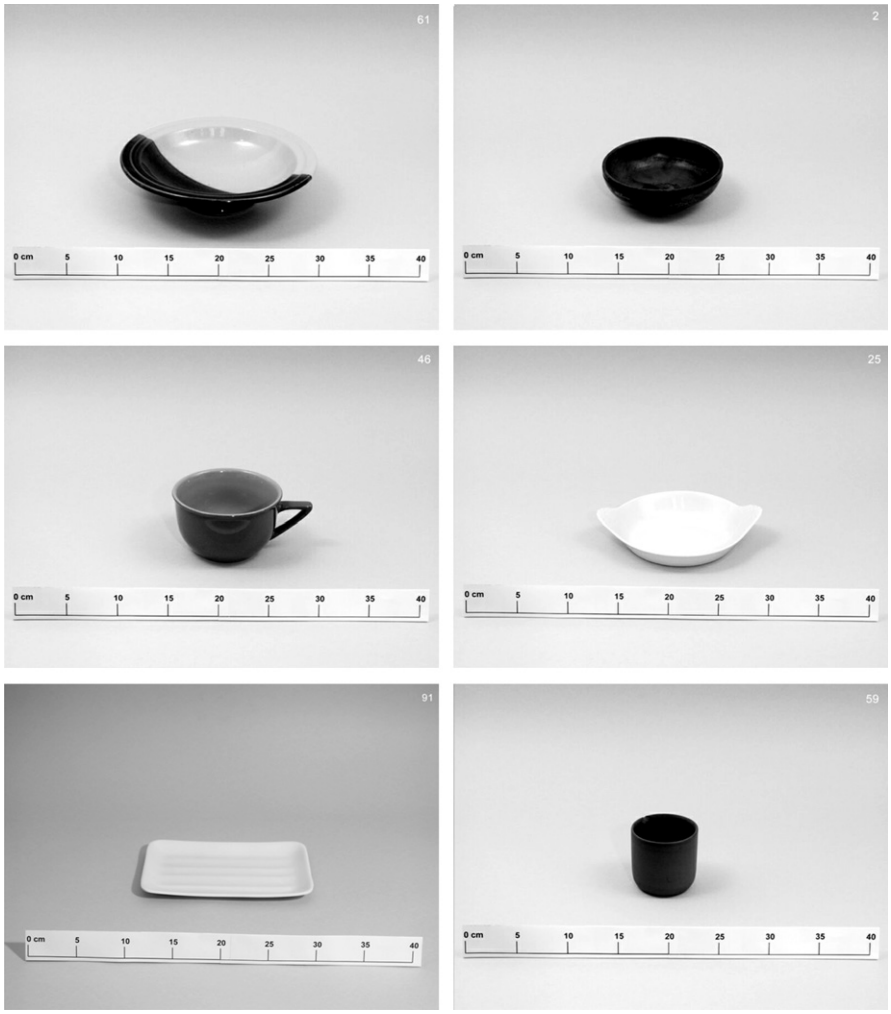

Fig. 3. Some of the exemplars of the dishes set used in the experiment.

shuffled, and the similarity judgment task was administered.[2]

The large number of objects prevented us from collecting direct pairwise similarity judgments. Instead we asked the participants to sort the objects into piles to provide a derived measure of similarity for each pair of objects as described below. The Dutch- and French-speaking monolingual participants were instructed, respectively, in Dutch and French; the bilinguals were instructed in the language they used in their first naming task. First, participants were asked to look through the pictures. Then they were told to focus on the overall qualities of each object,[3] i.e., to focus on any feature (or combination of features) of the object that seemed important or natural. For example, they were told for the bottles set that they might consider properties such as the shape of the container, the material of which it was made, and how it contains the substance that is in it (in a stack, in separate pieces, as a single solid, as a liquid, with pouring capability, etc.). They were instructed to put together into piles all the objects that seemed very similar to each other overall. For the bottles set, it was stressed that two containers holding things that tend to be found together (such as ketchup and mayonnaise), should not be put together unless the containers themselves were alike in an overall way.

[2] Note that the task order is opposite to the order in which Malt et al. (1999) presented the two tasks to the participants. However, the fact that we found the same dissociation between naming and sorting as Malt et al. even in this case (see Results and discussion) highlights the independence of the two tasks.

[3] In contrast to Malt et al. (1999), we did not collect physical and functional similarity sorts.

The participants were also instructed that they could use as many piles as they wanted, but that they should use at least two. They were told that they should not make a pile consisting of only one object unless they really could not place the object in one of the existing piles. They were given as much time as they wanted to complete the sort. In general, the sorting task took about 30 min.

Finally, in a second experimental session, 21 of the 25 bilingual participants (along with monolingual participants who were different from those who performed the naming and sorting reported here) provided typicality ratings for use in more detailed analyses, not reported here, of the structure of the linguistic categories (as per Malt et al., 2003). Participants were asked to rate, for each object, the degree to which it was a good example of three linguistic categories, selected from the naming task based on the criterion of most frequent dominant name.

Results and discussion

We first discuss the replication of Malt et al.'s (1999) study and then present the analyses of the bilingual naming data.

Replication of Malt et al. (1999)

Parallel to Malt et al. (1999), we studied the patterns of naming and the relation between linguistic categorization and perceived similarity of the artifacts by the Dutch- and French-speaking monolingual Belgians. The questions addressed are (a) whether Belgian Dutch and French speakers show differences in their naming patterns, and (b) whether they show a dissociation between naming and sorting as Malt et al. found for speakers of American English, Mandarin Chinese, and Argentinean Spanish.

Comparison of linguistic category boundaries

For each language group, we tallied the frequency of each name produced for each object. Tallies were based on the head noun of the response (e.g., *fles*, *plastic fles*, and *kleine fles* all counted as instances of the category *fles*). Monolexemic diminutive forms of names (e.g., *flesje* is a diminutive of *fles*) were combined with the non-diminutives and treated as a single category because adjective + noun versions of diminutives (e.g., *kleine fles* which means *small bottle*) were also counted as an instance of the category (e.g., *fles*). The first analysis is restricted to the dominant category name for each object, i.e., the most frequently produced name for each object.

Table 1 shows the dominant category names for the Dutch- and French-speaking participants for the bottles set, together with the number of objects out of 73 for which each name was dominant. To gain insight into the similarities and differences between the Dutch and French categories, the French categories are described in terms of their Dutch composition.

As can be seen in Table 1, for the Dutch-speaking monolinguals, 12 different names emerged as dominant for at least one object. There were three main categories, *fles*, *bus*, and *pot*,[4] together encompassing 74% of the stimulus set. The remaining names were dominant for four or fewer objects each. For the French-speaking monolinguals, 15 different names emerged as dominant for at least one object. Three category names, *bouteille*, *flacon*, *pot*,[5] together encompassed 58% of the stimulus set. The other names were restricted to a smaller number of objects. There are some clear resemblances in how the two languages classify the objects. Most of the objects called *pot* in Dutch (9/13) are put into one single French category *pot*. All Dutch *tubes* are put together into the French category *tube*. On the other hand, there are also prominent differences between the naming patterns of both languages. The 25 objects called *fles* in Dutch are split into two different categories in French: 13 objects are called *bouteille* and 10 are called *flacon*. The Dutch category *bus* does not have a close correspondence to any French category, with the objects called *bus* being spread over 6 French categories (*bouteille*, *flacon*, *spray*, *bidon*, *brique*, and *bombe*).

Similar conclusions apply to the dishes set (see Table 2). For the Dutch-speaking monolinguals, the dishes fell mainly into three categories, *kom*, *tas*, and *schaal*,[6] more or less equal in size and together covering 70% of the object set. Six other dominant names were given to fewer than 10 objects out of 67. For the French-speaking monolinguals, there were also three main category names, *plat*, *tasse*, and *bol*.[7] There are some clear correspondences between the languages. For instance, all the objects called *tas* in Dutch are put into the French category *tasse*; all the objects except one called *bord* in Dutch are grouped into one single French category *assiette*. In the French category *tasse*, there are only two additional objects that are not called *tas* in Dutch and the objects of the French category *assiette* are all called *bord* in Dutch, except for one. However, there are also notable differences between the French- and Dutch-speaking monolinguals in the way they partitioned the objects into linguistic categories. For example, the

[4] *Fles* is translated in dictionaries as *bottle*, *bus* as *can* and *pot* as *pot* or *jar*. However, as we noted before, these words are not assumed to be perfectly equivalent.

[5] *Bouteille* is translated in dictionaries as *bottle*, *flacon* as well as *bottle* and *pot* as *pot* or *jar*. However, as we noted before, these words are not assumed to be perfectly equivalent.

[6] *Kom* is translated as *bowl*, *tas* as *cup* and *schaal* as *dish* or *plate*.

[7] *Plat* is translated as *dish*, *tasse* as *cup* and *bol* as *bowl*.

Table 1
Linguistic categories for the bottles set for Dutch- and French-speaking monolinguals

Dutch bottles (monolinguals)	*N*	French bottles (monolinguals)	*N*	Dutch Composition (monolinguals)
fles	25	bouteille	16	13 fles, 3 bus
bus	16	flacon	16	10 fles, 3 bus, 2 pot, 1 roller
pot	13	pot	10	9 pot, 1 fles
brik	4	boîte	7	3 doos, 2 brik, 1 blik, 1 pot
doos	4	tube	6	4 tube, 1 pot, 1 stick
tube	4	spray	5	5 bus
blik	2	bidon	3	3 bus
mand	1	brique	2	1 bus, 1 doos
molen	1	berlingo	2	2 brik
roller	1	biberon	1	1 fles
stick	1	bombe	1	1 bus
vat	1	canette	1	1 blik
		pannier	1	1 mand
		poivrier	1	1 molen
		salière	1	1 vat

Table 2
Linguistic categories for the dishes set for Dutch- and French-speaking monolinguals

Dutch dishes (monolinguals)	*N*	French dishes (monolinguals)	*N*	Dutch Composition (monolinguals)
kom	19	plat	19	11 schaal, 7 kom, 1 bord
tas	15	tasse	17	15 tas, 1 beker, 1 pot
schaal	13	bol	12	11 kom, 1 schaal
bord	8	assiette	8	7 bord, 1 schaal
beker	4	chope	3	2 beker, 1 glas
pot	4	pot	3	3 pot
glas	2	bougeoir	1	1 houder
asbak	1	caquelon	1	1 kom
houder	1	cendrier	1	1 asbak
		gobelet	1	1 beker
		verre	1	1 glas

objects called *kom* in Dutch were subdivided into two categories by monolingual speakers of French: *plat* and *bol*. While the category *bol* contained almost exclusively objects called *kom* (except one object called *schaal*), the category *plat* also contained objects called *kom* plus most of the objects called *schaal* (11 out of 13).

By looking only at the dominant names, information present in the data are lost. For the bottles set, only five objects were called by the same name by every Dutch monolingual participant, and the same was true for the French monolingual participants. For the dishes set, none of the 67 objects was called by the same name by every Dutch monolingual participant, while only four objects were by every French monolingual participant. Therefore, in a second analysis, we used the name distribution for each object—that is, a vector of numbers (as many as there are names produced for the object set), where each entry indicates the number of times the name was produced for each object—to compare the naming patterns of the different language groups. For instance, for the bottles set, a total of 39 different names were produced by the Dutch monolinguals. If an object is called *bus* five times, *fles* 10 times, and *pot* two times, the name distribution of the object is an ordered series of 39 numbers, containing a 0 for each of the 36 names that are not used to name the object, a five for *bus*, 10 for *fles*, and a two for *pot*. Following Malt et al. (1999), we first compared the similarity of each object's name distribution to every other object's name distribution within each language group using a Pearson correlation. For each language group, the $n(n-1)/2$ correlations (2628 for the 73 bottles and 2211 for the 67 dishes) reflect the extent to which each pair of objects was named similarly by speakers of the language. We then correlated the 2628 (or 2211) name similarity values for one language group with the corresponding 2628 (or 2211) name

similarity values for the other language group. This correlation indicates the extent to which the two language groups correspond in the pairs of objects that have similar name distributions. For bottles, the correlation was .63; for the dishes, it was .80 ($p < .01$ for both and mean estimated reliabilities[8] of 0.93 and 0.94, respectively). Apparently, the Dutch- and French-speaking monolinguals agree better on naming of the dishes than on naming of the bottles (see also Malt & Sloman, 2003). The correlations are substantial, but far from perfect, since only 40 and 64% of the variance, respectively, is accounted for. Thus both the analysis of the dominant names and the correlation between the name distribution similarities indicate that the French- and Dutch-speaking monolinguals show distinct differences in their naming along with similarities. This conclusion holds both for the bottles and the dishes set.

A third way to evaluate the differences in naming among the language groups is by using the Cultural Consensus Model (CCM) of Romney, Weller, and Batchelder (1986). The CCM uses the pattern of agreement among participants to make inferences about the differences between languages. More concretely, for every pair of participants, a measure of association is computed. The measure of association stands for the proportion of 'matches' in naming of object pairs between two participants. Let X_{ikl} be 1 if participant i gave the same name to objects k and l and 0 if the participant did not. Analogously, X_{jkl} equals 1 if participant j named objects k and l similarly and 0 if the participant did not. N denotes the number of object pairs in the stimulus set. Then the measure of association between participants i and j is as follows:

$$M_{ij} = \sum_{k,l>k} (1 - | X_{ikl} - X_{jkl} |)/N.$$

A match occurs when both participants of the pair individually give the same name to the two objects of an object pair (i.e., $X_{ikl} = 1$ and $X_{jkl} = 1$) or when both participants individually give a different name to the two objects of an objects pair (i.e., $X_{ikl} = 0$ and $X_{jkl} = 0$). In these two cases, M_{ij} increases. Note that the measure of association presented here differs from the measure used by Malt et al. (1999): $M_{ij} = \sum_{k,l>k}(X_{ikl} * X_{jkl})/N$. They did not take the cases into account in which both participants individually gave a different name to the two objects of an object pair (i.e., $X_{ikl} = 0$ and $X_{jkl} = 0$). Only if both participants of the pair individually gave the same name to the two objects of an object pair (i.e., $X_{ikl} = 1$ and $X_{jkl} = 1$), M_{ij} increased. However, we judged that those cases were of the same relevance as the cases in which both participants individually gave the same name to the two objects of an object pair (i.e., $X_{ikl} = 1$ and $X_{jkl} = 1$).

Confirmatory factor analyses (CFA) were conducted on the resulting matrix of associations among the participants to reveal the underlying factor structure. If there were no group differences in naming, the best fitting model would be a model with one factor on which the two groups of participants should load equally. We expect that the two language groups differ in naming, which implies that the best fit should be yielded by a two-factor model in which one language group should load significantly higher than the other group on the first factor and vice versa for the second factor. The reduction in total χ^2 and the GFI statistic were used to assess model fit (Bentler & Bonett, 1980). For the two object sets, the decrease in χ^2 from the one-factor model to the two-factor model was statistically significant (bottles: $\Delta\ \chi^2 = 6266.69$, 1 *df*; dishes: $\Delta\chi^2 = 4267.42$, 1 *df*, both $ps < .001$). The GFI statistic, indicating the percentage of improvement in model fit compared to no model at all (Jöreskog & Sörbom, 1979), increased from 61 (one-factor model) to 71.49% (two- factor model) for the bottles and from 58 to 67% for the dishes. So, in agreement with Malt et al.'s results, we can conclude both for the bottles and for the dishes set that the monolingual language groups named the objects differently.

Comparison of perceived similarity

The data from the sorting task were used to obtain a measure of similarity for each pair of objects for each monolingual language group. Pairwise similarity was recovered by counting for each of the 2628 (or 2211) pairs of objects how many participants of a language group placed that pair of objects in the same pile. A large number of participants placing the two objects in a pile can be taken as indicating high perceived similarity and a smaller number as indicating lower perceived similarity. The similarity judgments of the two language groups were then correlated to determine whether the groups agreed on which pairs were more and less similar. The resultant correlation of .87 for the bottles set—comparable to the mean estimated reliability of 0.92—indicates that the French- and Dutch-speaking monolinguals agree to a considerable extent on the similarities among the bottles. For the dishes, similarly, we obtained a correlation of .88 (with mean estimated reliability of 0.92).

To compare agreement between the two language groups on sorting directly to that on naming, we applied the CCM to the sorting data. The analysis is analogous to the naming analysis except that instead of considering

[8] Reliability was evaluated by applying the split-half method, followed by the Spearman–Brown formula: First, the correlation is computed between the two halves of a task, which are treated as alternate forms (with halves referring to the frequencies for half of the participants). This "halves reliability" estimate (r_{half}) is then adjusted using the Spearman–Brown prediction formula ($2r_{\text{half}}/(1 + r_{\text{half}})$), resulting in an estimation of the reliability of the full task.

whether a participant gave two objects the same name or not, we consider whether the participant put them in the same pile or not. Here, we expect no group differences, which would be expressed in the superiority of a model with one factor on which the two language groups load equally over a two-factor model (as described above for the naming data). However, confirmatory factor analyses showed a significant decrease in χ^2 for the two-factor model compared to the one-factor model both for bottles and dishes (bottles: $\Delta\chi^2 = 737.62$, 1 *df*; dishes: $\Delta\chi^2 = 1620.5$, 1 *df*, both $ps < .001$). Yet, the improvement in fit from the one-factor model to the two-factor model was substantially smaller than the improvement found for the naming data. Moreover, the correlations between the sortings of the two monolingual language groups (.87 for bottles and .88 for dishes) are not significantly different from the within-group correlations (i.e., the correlation between the two halves of a group) (bottles: .87 and .83 for, respectively, the Dutch- and French-speaking monolinguals; dishes: .85 and .86 for, respectively, the Dutch- and French-speaking monolinguals). The latter result strongly suggests that the group differences in sorting are minimal.

In conclusion, for both object sets, the monolingual language groups showed substantial differences in naming and only small differences in sorting. These results replicate Malt et al.'s (1999) findings, obtained from speakers of English, Chinese, and Spanish, with speakers of two languages who live in close contact and largely share a culture. They demonstrate the pervasiveness of between-language differences in naming patterns for common objects, and they reinforce the conclusion that such differences do not derive from differences in the assessment of object similarity by speakers of the languages, nor from differences in item familiarity or cultural differences. Rather, they stem from differences in the histories of the languages.

Naming in bilinguals: Testing the hypothesis of two separate naming patterns

We now present correlational analyses and ANOVAs investigating how the French and Dutch naming patterns of the bilinguals relate to each other and how they are related to the naming patterns of the respective monolingual language groups. These analyses allow to discriminate between the two hypotheses about bilingual lexical organization, outlined in the Introduction, and a weaker version of the one-pattern hypothesis. Fig. 4 presents the hypotheses schematically. There are four circles in each scheme, one for each language of a language group (Dutch of the Dutch-speaking monolinguals, French of the French-speaking monolinguals, and Dutch and French of the bilinguals). The circles represent the naming patterns, that is, the way in which the language segments the stimulus space into categories. Naming patterns that converge, i.e., languages with parallel category extensions are represented by one circle instead of two. The lines between the circles express the relations between the naming patterns. Fig. 4A shows the initial model or structure used to represent the six correlations between each pair of language groups.

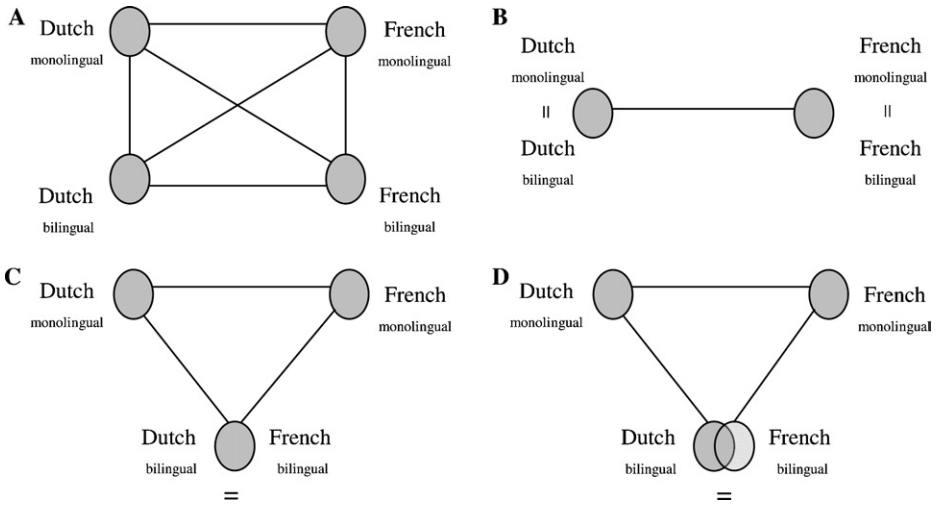

Fig. 4. Schematic representations of the predictions of the different hypotheses postulated for the bilingual lexicon. (A) The initial model or structure used to represent the six correlations between each pair of language groups. $\text{Dutch}_{\text{monolingual}}$ denotes the naming pattern of the Dutch-speaking monolinguals, $\text{French}_{\text{monolingual}}$ the naming pattern of the French-speaking monolinguals, $\text{Dutch}_{\text{bilingual}}$ and $\text{French}_{\text{bilingual}}$, respectively, the Dutch and French naming pattern of the bilinguals. The remaining charts show the pattern of correlations predicted by the two-pattern hypothesis (B), the strong version of the one-pattern hypothesis (C) and the weaker version of the one-pattern hypothesis (D).

In the two-pattern hypothesis (Fig. 4B), bilingual naming follows the naming of the monolinguals. In our specific case, the French naming of bilinguals will be indistinguishable from the naming pattern of monolingual French speakers, and the Dutch naming pattern of bilinguals will be indistinguishable from that of Dutch monolinguals. The two-pattern hypothesis predicts that the bilinguals will show as large differences between their French and Dutch naming patterns as were found between the French and Dutch monolinguals.

The one-pattern hypothesis is that the bilinguals use one common naming pattern in the two languages (Fig. 4C). The two distinct monolingual patterns are merged to produce a single naming pattern. There are two possible versions of the one-pattern hypothesis. The stronger version is that the merging is complete and the French and Dutch linguistic categories of the bilinguals perfectly coincide with each other. A more moderate version of the one-pattern hypothesis is that the bilingual naming patterns converge toward one common naming pattern, but the match is not perfect (Fig. 4D). Note that the position of the circle representing the merged naming pattern in Figs. 4C and D depends on the relative influence of the languages, and can vary from the far left (largely dominated by Dutch) over the center (a balanced situation with equal weight of Dutch and French), to the far right (largely dominated by French). To determine which of the three possibilities (two-pattern and strong vs. moderate version of the one-pattern hypothesis) corresponds to the true situation, we analyzed the data on both group and individual levels. The group-level analysis allows us to compare the naming data between groups (Dutch-speaking and French-speaking monolinguals, bilinguals in Dutch and French) and within the group of bilinguals (Dutch and French bilingual naming), while the individual-level analysis allows a better comparison of the naming data between and within subjects of the different language groups. We first evaluate the two-pattern hypothesis against the strong version of the one-pattern hypothesis; we then consider the more moderate version of the one-pattern possibility.

Group-level analysis

Correlations were calculated between the measures of name similarity (i.e., name distribution similarities) of all the language groups ($Dutch_{monolingual}$, $French_{monolingual}$, $Dutch_{bilingual}$, and $French_{bilingual}$). The middle panel of Fig. 5 shows the predicted pattern of correlations for the two- (B) and one-pattern hypothesis (C). As in

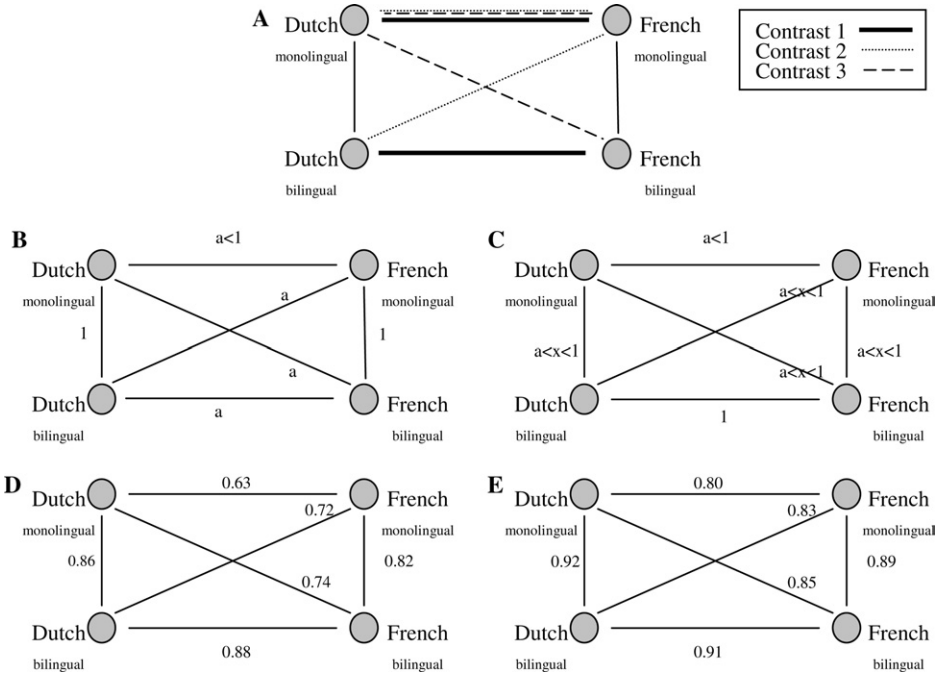

Fig. 5. Patterns of correlations between the name distribution similarities of the language groups. (A) The upper panel represents the 3 contrasts to be tested: Contrast 1 tests whether the correlation between monolinguals and the correlation between bilinguals are different, Contrasts 2 and 3 test whether the correlation between monolinguals and the correlation between monolinguals and bilinguals tested in a different language are different. The middle panel shows the correlations predicted by respectively the two-pattern (B) and the one-pattern hypothesis (C). The lower panel shows the observed correlations for the bottles set (D) and the dishes set (E).

Fig. 4, the circles correspond to the naming patterns of the different language groups. The lines between the circles express the correlations between the naming patterns of the different language groups. Note that the correlation between the Dutch and French bilingual naming patterns concerns a comparison within the same group, but not within subjects, since the correlation is based on aggregated data.

Let a be the correlation between the French and Dutch monolingual naming patterns, which we have already found to be significantly lower than 1. To distinguish between the one- and two-pattern hypotheses, three contrasts are crucial (see Fig. 5A). The first contrast assumes that there is no difference between the correlation between the bilingual naming patterns and a, a claim made by the two-pattern hypothesis. If this contrast is rejected, it remains to be tested whether the correlation between the bilingual patterns is significantly larger than a, since the strong version of the one-pattern hypothesis predicts that there will be a perfect match between the two naming patterns of bilinguals. The second and third contrasts concern the monolinguals and bilinguals tested in a different language and can be considered as indirect measures of the influence of the one language over the other and vice versa. These contrasts assume that the correlations between monolinguals and bilinguals tested in a different language (i.e., the correlation between the Dutch-speaking monolinguals and the bilinguals in French and the correlation between the French-speaking monolinguals and the bilinguals in Dutch) are equal to a. This is predicted by the two-pattern hypothesis and reflects its assumption of no mutual influence between the two languages. If these assumptions are rejected, we can test whether the correlations are significantly higher than a. This claim is made by the strong one-pattern hypothesis that assumes direct or indirect interactions between the two languages of a bilingual, resulting in a higher correlation than a.

The lower panel of Fig. 5 shows the observed pattern of Pearson correlations for the bottles set (D) and for the dishes set (E).

The data are inconsistent with the two-pattern-hypothesis, since all contrasts are rejected. For the first contrast, we found for both object sets that the correlation between the two naming patterns of the bilinguals (.88 for the bottles, .91 for the dishes) is significantly larger than a (.63 for the bottles, .80 for the dishes), $Z = 22.98$, $p < .0001$ for the bottles, $Z = 14.25$, $p < .0001$ for the dishes. For the second and third contrast, we found that the correlations between the naming patterns of monolinguals and bilinguals in a different language are significantly larger than a for the bottles and for the dishes (bottles, contrast 2: $t = 9.39$, $p < .0005$, contrast 3: $t = 8.54$, $p < .0005$; dishes, contrast 2: $t = 4.44$, $p < .0005$, contrast 3: $t = 6.63$, $p < .0005$). The results are in line with the hypothesis of one common naming pattern,[9] but they also suggest that the strong version is too strong, since the correlation between the two naming patterns of the bilinguals does not equal 1. A more moderate version must be considered.

However, there is a disadvantage attached to the group level analysis: the name distribution similarities (calculated for each pair of objects), correlated among language groups, are based on aggregated data, possibly obscuring individual differences. Therefore, we also examined the data on the individual level.

Individual-level analysis

On the individual level, object × object matrices were constructed for each individual naming task (i.e., each single task performed by a participant, meaning that each bilingual performs at least two individual tasks, one in each language), containing 0s and 1s, with 1 indicating the same name given to both objects by the participant performing the task and 0 indicating different names given to the two objects. A total of 126 individual matrices (one for each individual task) were included in the analysis: 32 for the Dutch-speaking monolinguals, 5 for retested Dutch-speaking monolinguals, 29 for French-speaking monolinguals, 25 for bilinguals naming in Dutch, 5 retested bilinguals naming in Dutch, 25 bilinguals naming in French naming, and 5 retested bilinguals naming in French. This resulted in $126 * 125/2$ correlations between all possible pairs of individual matrices. The naming data of the retested participants were not included in the group-level analysis, since the group-level analysis did not aim at making within-group comparisons between naming data in the same language. Next, the correlations were Z'-transformed to normalize the sampling distribution of the correlations, with $Z' = 0.5 * \ln[(1 + r)/(1 - r)]$. Then, the Z'-transformations of the correlations were analyzed in a randomized block factorial ANOVA design, with three factors: language (two levels: the participants of the pair perform the naming task in the same language or in a different language), person (two levels: correlation between naming data of the same participant or of different participants) and linguistic status (three levels: both

[9] One might raise the possibility that the convergence of the Dutch and French bilingual naming patterns is induced by the repetition of the naming task: Naming in the second language (French for half of the participants and Dutch for the other half) might be influenced by the naming in the first language (Dutch for half of the participants and French for the other half). However, no effect of language order was found. The group-level analysis, described in the Results and discussion section, was performed for the two levels of language order separately (naming first in French vs. naming first in Dutch). This analysis yielded the same results as the results found for the group as a whole.

participants are monolingual, one is monolingual and the other bilingual, or both are bilingual), resulting in a $2 \times 2 \times 3$ design with unequal cell frequencies and three empty cells (see Fig. 6). The three cells without any observations are structurally empty, because it is impossible to calculate a correlation (a) between two individual tasks (in the *same* language or in a *different* language) performed by the *same* person and where both people (who are the same) have a *different* linguistic status and (b) between two individual tasks in a *different* language performed by the *same monolingual* person. To distinguish between the one- and the two-pattern hypotheses, the interaction of language with linguistic status is crucial, since the two hypotheses make opposing predictions. The predictions are depicted visually in Figs. 7B–D. According to the two-pattern hypothesis, the bilinguals' Dutch naming pattern is the same as the naming pattern of the Dutch monolinguals, and their French naming pattern is the same as that of the French monolinguals. Both for monolinguals and for bilinguals, the hypothesis of two naming patterns predicts that naming in the same language will result in higher correlations than naming in a different language. So, the two-pattern hypothesis predicts a significant main effect of language and no interaction between language and linguistic status.

According to the strong version of the one-pattern hypothesis, the two naming patterns of the bilinguals merge into one single naming pattern, used for naming in both languages. Hence, we are left with only three separate naming patterns: the Dutch monolingual naming pattern, the French monolingual naming pattern and

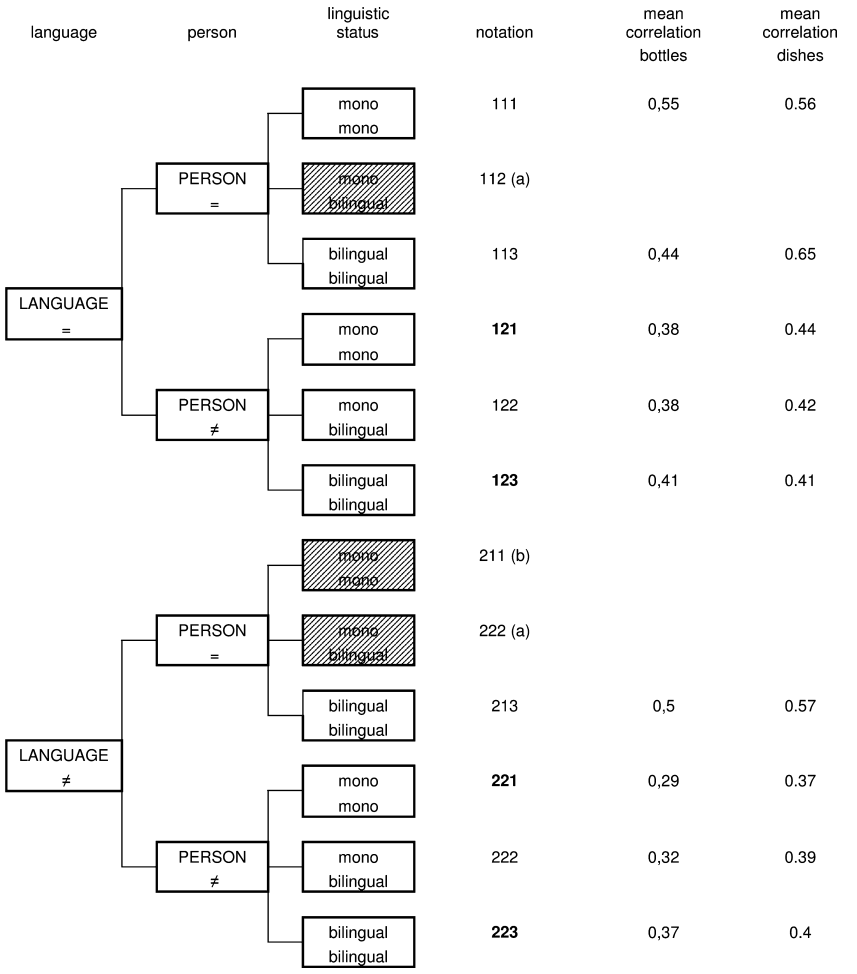

Fig. 6. $2 * 2 * 3$-Factorial design with unequal cell frequencies and three empty cells. The number in the first column of numbers ('notation') consists of three indices denoting the three factors of the design: language [first index with values 1 (same language) and 2 (different language)], person [second index with values 1 (same person) and 2 (different person)], and linguistic status [third index with values 1 (two monolinguals), 2 (one monolingual and one bilingual), and 3 (two bilinguals)]. The letters a and b between brackets indicate the two types of structurally empty cells, described in the article. The last two columns contain the mean correlations for the bottles set and the dishes set.

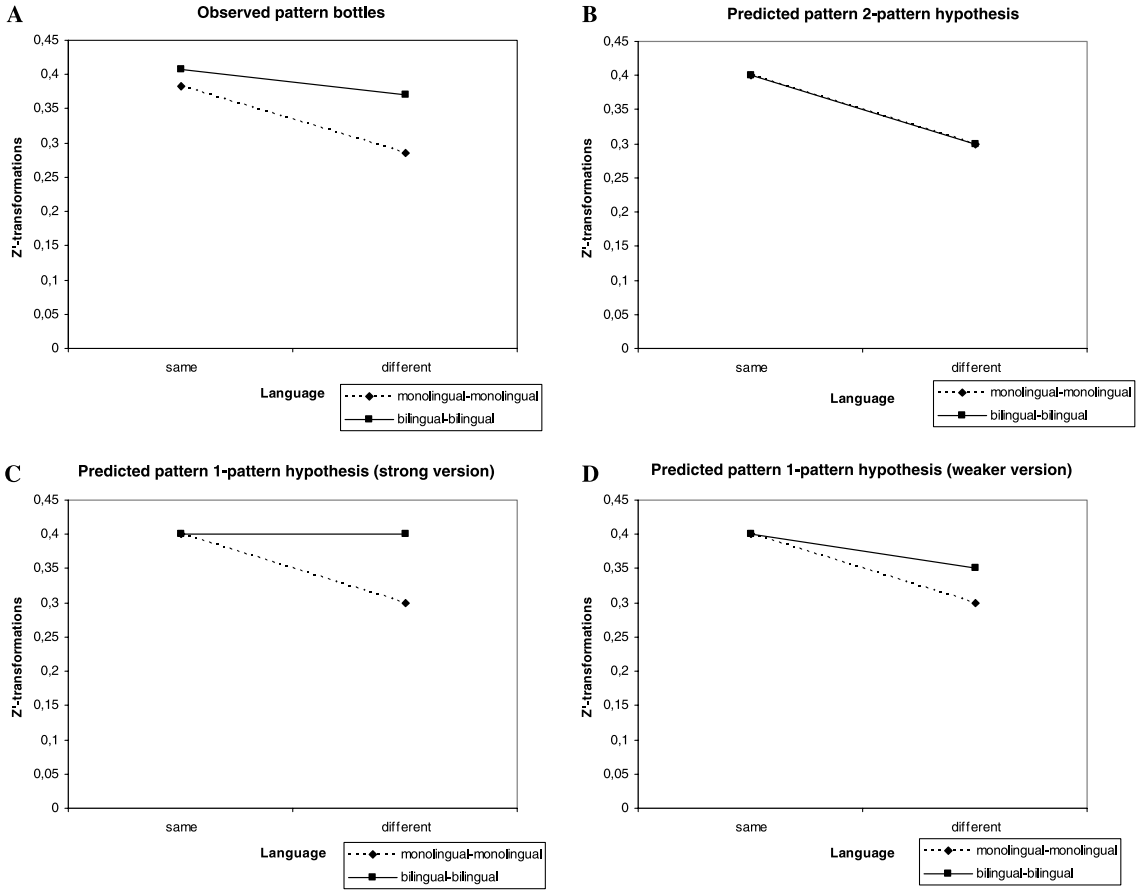

Fig. 7. Interaction effect between language and linguistic status. Observed pattern of results for the bottles (A), pattern of results predicted by the two-pattern hypothesis (B), pattern of results predicted by the strong version of the one-pattern hypothesis (C) and pattern of results predicted by the weaker version of the one-pattern hypothesis (D).

the (merged) bilingual naming pattern. For the monolinguals, the strong one-pattern hypothesis predicts the same as the two-pattern hypothesis: two 'people' naming in the same language will agree better with one another than two 'people' naming in different languages. For the bilinguals, on the other hand, no language effect is predicted, since the bilingual naming patterns for each language converge. The prediction of the more moderate version of the one-pattern hypothesis differs from that of the stronger version, in the sense that the moderate version allows a language effect for bilinguals, but a much smaller one than for monolinguals.

In sum, if we find a language effect both for monolinguals and for bilinguals going in the same direction (i.e., absence of interaction between language and linguistic status), the two-pattern hypothesis is confirmed. The emergence of an interaction effect between language and linguistic status, manifested in a language effect for monolinguals but absence of it for bilinguals, favors the strong version of the one-pattern hypothesis. A finding of an interaction with a stronger language effect for monolinguals than for bilinguals would support the weaker version of the one-pattern hypothesis.

The results of the ANOVA confirmed the conclusions that were derived from the correlational group-level analysis. The three main effects—language, person, and linguistic status—were all significant for the bottles, respectively, $F(1,7866) = 23.29$, $p < .0001$, $F(1,7866) = 42.61$, $p < .0001$ and $F(2,7866) = 8.15$, $p < .0005$. The same results hold for the dishes, except for the effect of linguistic status that was only marginally significant, respectively, $F(1,7866) = 19.22$, $p < .0001$; $F(1,7866) = 72.74$, $p < .0001$; and $F(2,7866) = 2.51$, $p < .1$. The significant language effect found for both object sets indicates that the correspondence between two naming tasks in the same language was higher than between two naming tasks in a different language. The effect of person shows that two naming tasks performed by the same person correspond better than two naming tasks performed by different persons. For the linguistic

status, we found for both object sets that the mean correlation between naming of two bilinguals was significantly higher than the mean correlation between naming of a bilingual and a monolingual (bottles: $F(1,7866) = 39.72$, $p < .0001$; dishes: $F(1,7866) = 4.61$, $p < .05$). The latter was significantly higher than the correlation between naming of two monolinguals for the bottles, but not for the dishes (bottles: $F(1,7866) = 148.23$, $p < .0001$). The interaction between language, person and linguistic status was also significant (bottles: $F(4,7866) = 25.05$, $p < .0001$; dishes: $F(4,7866) = 17.71$, $p < .0001$). (Note that, due to empty cells, it is impossible to estimate at the same time the two-way interaction effects and the three-way interaction effect.)

To distinguish between the one- and the two-pattern hypotheses, we inspected the interaction effect of language and linguistic status by testing the language effect for two levels of linguistic status (two monolinguals vs. two bilinguals)[10] by means of two contrasts. Fig. 7A shows the results for the bottles.

The first contrast tests the language effect for monolinguals (when the participants are different). If the correlation between the naming tasks of (two different) monolinguals in the *same* language is significantly higher than the correlation between the naming tasks of (two different) monolinguals in a *different* language, then there is a language effect for monolinguals, a conclusion consistent with both hypotheses. This contrast was significant, both for the bottles and for the dishes (bottles: $F(1,7866) = 483.09$, $p < .0001$; dishes: $F(1,7866) = 225.36$, $p < .0001$), an outcome excluding alternative hypotheses.

The second contrast tests the language effect for bilinguals (when the tasks that are correlated are performed by two different participants). This contrast was significant, both for the bottles and for the dishes (bottles: $F(1,7866) = 71.83$, $p < .0001$, dishes: $F(1,7866) = 10.27$, $p < .005$), indicating that the naming tasks in the same language of (two different) bilinguals correspond to a higher degree than the French and Dutch naming task of (two different) bilinguals.

Based on the results of both contrasts, a language effect both for monolinguals and for bilinguals, the strong version of the one-pattern hypothesis is defeated. Now, it remains to be seen whether the language effects for monolinguals and bilinguals parallel each other—an outcome that favors the two-pattern hypothesis, or whether the language effect for bilinguals is smaller than the one for monolinguals—an outcome that favors the weaker version of the one-pattern hypothesis. Therefore, we compared Contrast 1 with Contrast 2. This comparison was significant for both object sets (bottles: $F(1,7866) = 70.17$, $p < .0001$; dishes: $F(1,7866) = 58.44$, $p < .001$), showing that the language effect for monolinguals is significantly larger than the language effect for bilinguals. This conclusion argues against the two-pattern hypothesis and favors a more moderate version of the one-pattern hypothesis.

[10] The level 'monolingual–bilingual' is not included in the analysis, since we are not interested in this level.

General discussion

Dissociation of naming and sorting

Using French- and Dutch-speaking monolingual Belgians, we replicated the findings both of different linguistic segmentation of common objects by different languages and of a dissociation between linguistic categorization (naming) and non-linguistic understanding (sorting) obtained by Malt et al. (1999) for speakers of English, Spanish, and Chinese. The analysis of the dominant names, the analysis of similarities among naming distributions, and the application of the Cultural Consensus model revealed substantial differences between the naming patterns of French- and Dutch-speaking monolinguals. In contrast, virtually no differences were found in their perceptions of the commonalities among the objects, as revealed by the high correlation between the sorting data of the two monolingual language groups and by the CCM. The dissociation was found both for the bottles set and for the dishes set. This finding is consistent with Levelt et al.'s (1999) distinction between universal non-linguistic and language-specific lexical concepts (see also Bierwisch & Schreuder, 1992; Levinson, 1997). Based on this result, we can conclude that naming is not fully driven by the shared understanding of commonalities among the objects. Language-specific factors as well as similarity must contribute to how people segment a domain into linguistic categories. The fact that we replicated Malt et al.'s (1999) results with language groups that live in close proximity and share virtually the same culture supports Malt et al.'s argument that naming patterns are affected by a language's history. The vocabulary of each language (or dialect) appears to evolve over time and to be shaped by mechanisms such as *convention*, *pre-emption*, and *chaining*.

A particular name can become associated to an object by linguistic *convention* rather than because of specific similarity relations to other objects associated with the category name; for instance, the name can be introduced by a manufacturer. Pre-emption occurs when people may avoid calling an object by a particular category name because using that name would lead to ambiguity or confusion with another object. Fig. 8 shows some examples found in our data set of naming that may reflect convention and pre-emption. The object in Fig. 8A was called *beker* by most of the Dutch-speaking

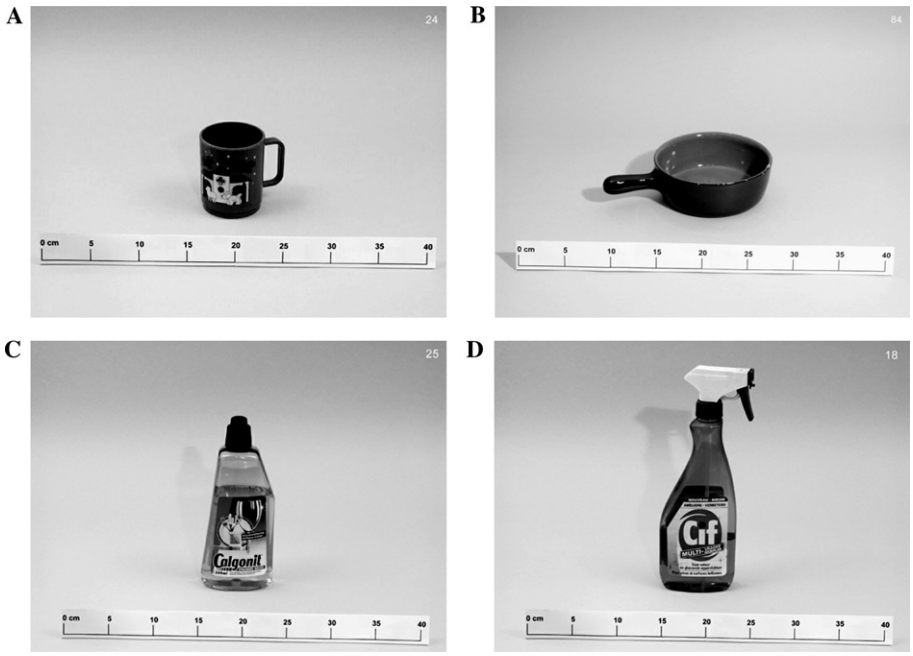

Fig. 8. Illustration of a combination of convention and pre-emption (A and B) and of chaining (C and D): (A) An object of the dishes set named *beker* by Dutch-speaking monolinguals with higher average similarity to the *tas* category and the nearest neighbor being a *tas*. (B) An object of the dishes set named *caquelon* by French-speaking monolinguals with higher average similarity to the *plat* category and the nearest neighbor being a *plat*. (C) An object of the bottles set, named *fles* by the Dutch-speaking monolinguals, with higher average similarity to the *bus* category. (D) An object of the bottles set named *spray* by French-speaking monolinguals with higher average similarity to the *bouteille* category.

monolinguals, but its average similarity was greater to the objects called *tas* (Dutch for cup) than to the other objects called *beker*, and its nearest neighbor was a *tas*. This object may therefore be named *beker* and not *tas* by convention rather than because of similarity. The origin of this convention may have been a pre-emption. The word *beker* in Dutch is used for a plastic cup even though its features fall within the range of objects called *kop* or *tas* (cup). But calling it a *kop* or *tas* would create referential confusion with porcelain cups. The use of *kop* or *tas* for the plastic cup may therefore be *pre-empted* by the other uses of these names. The name *beker* is used here to distinguish it from porcelain cups. A similar example was found for the French-speaking monolinguals (Fig. 8B).

Chaining is at work when an object, similar to central examples of a category (C_1) receives a different name (C_2) through links to near neighbors that are more typical objects of the C_2 category and that may be at some distance from central examples of the C_1 category. Fig. 8C shows an object of the bottles set that was called *fles* by Dutch-speaking monolinguals, although it was more similar on average to objects labeled *bus*. We suggest that the object has received its name through links to more typical objects in the *fles* category. Fig. 8D shows a similar example for the French-speaking monolinguals. As Malt et al. (1999) note, we are not able to reconstruct all the links in the chain that may lead to the name *fles*, since our set of stimuli, though selected with the intention of representing the variability that exists within each domain, is not an exhaustive collection of all the forms of dishes that currently exist or historically did exist during the evolution of the current naming pattern.

Evidence against two separate naming patterns in bilinguals

The second, and primary, goal of the study was to evaluate the nature of lexical knowledge of bilinguals. Do the bilinguals maintain two separate sets of mappings of word forms to referents, one for each language (the two-pattern hypothesis), or do the naming patterns converge onto one naming pattern (the one-pattern hypothesis), implying some form of interconnections or feedback loops between the sets of word forms of the two languages and knowledge about their referents? The data force us to reject the two-pattern hypothesis. At the group level both for the bottles and for the dishes set, the correlation between the measures of name similarity of the bilingual naming patterns was significantly higher than the correlation between the monolingual naming patterns, indicating that the bilinguals in their

two languages agree significantly better on naming than the monolinguals. The correlations between the bilingual naming patterns were even very close to 1 (.88 for bottles and .91 for dishes), suggesting that the categories created in the two languages are very similar. At the individual level, we found an interaction between language and linguistic status. Monolinguals agree better upon naming in the same language than in a different language, while bilinguals agree only a little better on naming in the same language than in a different language. This result is inconsistent with the two-pattern hypothesis, which predicts a perfectly coinciding language effect for both monolinguals and bilinguals. So, the French and Dutch naming patterns of the bilinguals do not parallel the naming patterns of the French and Dutch monolinguals, respectively.

However, the result does not confirm the strong version of the one-pattern hypothesis either. The observed interaction deviates slightly from the interaction predicted by the strong one-pattern hypothesis. This fact suggests that the assumption of a perfect match between the naming patterns is too strong, since it would imply that bilinguals treat all French category names as having perfect translation equivalents in Dutch or vice versa. The data do confirm the more moderate version of the one-pattern hypothesis, indicating that the two naming patterns of the bilinguals are not kept separate, but, apart from some minor deviations, merge into one single naming pattern. The moderate hypothesis allows the portions of stimulus space associated with a word in one language and its translation equivalent in the other language to be more shared than they are in monolinguals, but not perfectly identical. The contents of the linguistic categories for the domain of bottles and for the domain of dishes are not fully, but largely shared across the two languages (see also Table 3).

The observation that some subtle differences remain reinforces the need for models of the bilingual lexicon to incorporate a mechanism or level of representation that allows for language-specific semantic knowledge as well as shared non-linguistic concepts (cf. Kroll & Stewart, 1994). Van Hell and De Groot (1998), for instance, proposed a distributed conceptual memory model in which a word is represented as a pattern of activation across a network of interconnected units or features. This model was developed to account for differences in the extent to which a bilingual's lexical knowledge overlaps for the two languages depending on word-type and grammatical class (e.g., abstract vs. concrete words; nouns vs. verbs). Such a model could also presumably accommodate varying degrees of overlap in semantic knowledge for concrete nouns, while the feature space itself is common to both languages.

Through a concrete example, we will illustrate the higher though not perfect correspondence in bilingual naming patterns compared to the monolingual naming patterns. A first observation in the bilingual naming data is that the group of objects named *fles* in Dutch is subdivided into two major linguistic categories in French: 'bouteille' (21/30) and 'flacon' (6/30), at first sight suggesting dissimilar category boundaries in the two languages. The same nesting relation was found for the monolinguals, but in contrast to the unequal distribution of objects among the French bilingual categories, the objects named *fles* by the monolinguals were spread more equally among the two French categories: 13 out of the 25 *fles* objects were called *bouteille* and 10 were called *flacon*. For the bilinguals, then, the category of objects called *flacon* shrinks in favor of the *bouteille* category. This can be explained by the influence of Dutch on the French bilingual naming pattern: the word *bouteille*–generally presented as the translation

Table 3
French and Dutch linguistic categories for the bottles set and the dishes set for the bilinguals

Dutch bottles (bilinguals)	*N*	French bottles (bilinguals)	Dutch dishes (bilinguals)	*N*	French dishes (bilinguals)
fles	30	21 bouteille, 6 flacon, 2 pot, 1 biberon	asbak	1	1 cendrier
pot	11	10 pot, 1 bouteille	beker	4	2 tasse, 1 chope, 1 gobelet
doos	7	5 boîte, 2 carton	bord	7	6 assiette, 1 bol
tube	6	6 tube	glas	4	2 verre, 1 chope, 1 tasse
bus	4	4 spray	houder	1	1 chandelier
spray	4	4 spray	kom	20	12 bol, 5 plat, 3 pot
blik	3	2 boîte, 1 canette	pan	1	1 plat
brik	2	2 boîte	pot	1	1 pot
bidon	1	1 bidon	schaal	12	12 plat
emmer	1	1 pot	schotel	2	2 plat
mand	1	1 panier	tas	14	14 tasse
molen	1	1 moulin			
roller	1	1 rolleur			
vat	1	1 salière			

equivalent for *fles* in paired associate learning—is applied by bilinguals to all types of objects called *fles* in Dutch. The word *flacon*, in contrast, refers more specifically to a small bottle containing perfume or tablets. Through the years, the use of *flacon* might have been introduced in the vocabulary of French native speakers (monolinguals) to differentiate small bottles holding perfume or tablets from the more ordinary bottles (pre-emption). The Dutch-speaking monolinguals do not have a distinct category name for this kind of more atypical bottles. For bilinguals, both naming patterns seem to be unaffected by this mechanism of pre-emption. Putting the French monolingual and bilingual naming patterns side by side, we can say that a *restructuring* (Pavlenko, 1999) has taken place for the extension of *bouteille*. Compared to the monolingual concept of *bouteille*, different elements are incorporated in the bilingual concept of *bouteille* in such a way that *bouteille* and *fles* are parallel.

An influence of French on the Dutch naming pattern of bilinguals can also be seen. For example, bilinguals use the name *(spuit)bus* in Dutch exclusively for objects called *spray* in French, while for Dutch-speaking monolinguals, the portion of representational space associated with *(spuit)bus* is much larger, including larger types of bottles containing cleaning products. Hence, for the bilinguals, the category boundary of the Dutch name *bus* is determined by the boundary of the French category name *spray*.

Overall, we found more evidence for an influence of Dutch on French than vice versa. This can be explained by the fact that in the language history questionnaire most of our bilinguals reported themselves to be a little more proficient in Dutch than in French (68% for Dutch compared to 8% for French, with 24% being equally proficient in the two) or reported themselves as thinking spontaneously in Dutch rather than in French (64% for Dutch vs. 20% for French, with 16% reporting thinking as much in the two languages). Most of the bilinguals were students of a Dutch-language university or college. Keeping the language input permanently balanced is extremely difficult (Schaerlaekens, 1998). As the child grows older, if the language spoken outside the home is the same as one of the two "home" languages, this language may play a more decisive role in naming than the other "home" language. Besides language dominance, language-specific properties that favor one language over the other (e.g., the number and ambiguity of lexical alternatives) may also drive the common naming pattern more in the direction of one language.

Mechanisms such as chaining, convention, and pre-emption still contribute to naming choices of bilinguals, but these sources of cross-linguistic diversity seem to operate to a smaller degree upon naming of bilinguals than upon naming patterns of monolinguals (e.g., the *bouteille–flacon* example described above). This might be explained by the fact that bilingual naming is the result of a merging of the two languages, and hence their naming patterns are not a direct reflection of the historical influences upon the patterns of either language.

Will these results generalize to other types of bilinguals?

Bilingualism refers to a heterogeneous group of situations. Therefore, conclusions about the lexical organization of one type of bilinguals cannot automatically be generalized to other types of bilinguals having a different language acquisition history. The participants of our study were compound bilinguals, who have grown up with two native tongues. From childhood, their parents have each consistently spoken their own language to the child, and the child acquires the two in parallel. This learning situation may be particularly likely to foster direct connections or feedback loops between the lexical knowledge of the two languages that will lead to a merged naming pattern. The merged naming pattern that we found for the bilinguals was not completely symmetric: Dutch influenced French more than French influenced Dutch. As mentioned earlier, this asymmetry is probably due to Dutch language dominance for most of the participants. Apparently, the common naming pattern is shaped by the two languages, but the position of the common naming pattern can still vary according to the dominance of one language over the other. Another type of bilinguals is the group of subordinative bilinguals who learn the second language as a foreign language at a later age than the first (native) language. Malt and Sloman (2003) found that the English naming patterns of second language learners low in proficiency diverged substantially from naming of native speakers of English. More advanced learners improved, but even those with the most English language experience retained some discrepancies from native patterns. Malt and Sloman (2003) suggested that people learning a second language might start the second language acquisition by importing the word–object mappings from L1 (see also Jiang, 2000; Kroll & Stewart, 1994; Potter et al., 1984). So, for these learners, the influence may be unidirectional: from L1 to L2. This may result in a common naming pattern for both languages completely dominated by (and so, similar to) L1. This common naming pattern will differ from the common naming pattern of compound bilinguals, which is shaped by a mutual influence between the two languages. As second language learners acquire more L2-specific environmental input about the correct mappings of L2, they adjust the word–object connections in L2 (Malt & Sloman, 2003). However, their adjustments may never be quite sufficient for various reasons. For instance, there may be a lasting interference from the native language pattern of links between word forms and object

representations, both because this pattern is initially been imported and because most second language learners continue to use the first language in many contexts (Jiang, 2000; Kroll & Curley, 1988; Kroll & Stewart, 1994; Malt & Sloman, 2003).

On the other hand, we also suggest the possibility that acquiring the second language vocabulary might have a backward effect on the first language mappings, providing the possibility that the two naming patterns of the advanced learners will come closer to each other and converge toward a single naming pattern. Pavlenko (1999) found that Russian second language learners of English experienced a shift in the extensions of the Russian equivalents *chastnoye* (private) and *lichnoye* (personal), resulting in incorrect use of the words in Russian. Wolff and Ventura (2003) similarly found evidence for a backward effect of a second language on the first in the domain of semantics, and Dussias (2001, 2003) has shown such backward influences on parsing preferences for Spanish–English bilinguals. However, we presume that the convergence toward one common naming pattern will never be as strong for the advanced second language learners as for the compound bilinguals, since the former learn their languages in different contexts and separated in time. Finally, for coordinate bilinguals who acquire and use their two languages in distinct environments or separate contexts, we would likewise expect some interaction between the two languages but less than for compound bilinguals.

Conclusion

We explored whether the linguistic category boundaries of the two languages are shared in the bilingual lexicon. We found that for two subsets of the domain of concrete objects (bottles and dishes), the naming patterns in the two languages of compound bilinguals converge on one common naming pattern, with only minor deviations. Through the mutual influence of the languages, the category boundaries in the two languages move towards one another and hence diverge from the boundaries drawn by the native speakers. The merged naming pattern that bilinguals use to name objects in the two languages is partially consistent with both languages. In other words, for the most part it satisfies language-specific constraints of both languages. However, the convergence of the two naming patterns on one naming pattern suggests that bilinguals do not only satisfy linguistic constraints, but also individual cognitive constraints: it is less demanding on the limited resources of memory to store only one set of mappings between objects and names. So, bilinguals settle on a set of mappings between words and objects that provides a compromise solution to the competing linguistic and individual memory constraints.

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