To appear in E. Margolis and S. Laurence (Eds.), *Concepts: New Directions*. Cambridge, MA: MIT Press.

Where are the Concepts?
What Words Can and Can't Reveal

Barbara C. Malt
Lehigh University
Silvia Gennari
University of York
Mutsumi Imai
Keio University at Shonan-Fujisawa
Eef Ameel
University of Leuven
Noburo Saji
Keio University at Shonan-Fujisawa
Asifa Majid
Center for Language Studies and Donders Institute for Brain, Cognition and Behaviour, Radboud University Nijmegen
and Max Planck Institute for Psycholinguistics

Corresponding Author:
Barbara Malt
Department of Psychology
17 Memorial Drive East
Lehigh University
Bethlehem, PA 18015
United States
Email: barbara.malt@lehigh.edu
Phone: +1 610-758-4797
Fax: +1 610-758-6277

Word count: 10,070

Where are the Concepts?
What Words Can and Can't Reveal

1. Introduction

1.1 Overview

To study concepts, cognitive scientists need to be able to identify them. The prevailing assumption has been that general-purpose, non-linguistic concepts are revealed by words such as *triangle*, *table*, and *robin.* But languages vary dramatically in how they carve up the world by name[1]. Either these concepts are heavily language-dependent or the words of a language cannot be a direct route to them. In this chapter we argue that the second of these possibilities is true. We illustrate our point with a study of words for human locomotion. This study shows that shared conceptual content across four languages is distinct from the answers suggested by any single language. It supports the conclusion that words such as *triangle*, *table*, and *robin* do not individuate general-purpose concepts. However, they can identify underlying components of domain knowledge, which suggests new approaches to understanding conceptual representation.

1.2 The Word-Concept Problem

Smith and Medin (1981) opened *Categories and Concepts* by declaring that concepts give human experience stability and that mental life would be chaotic without concepts. Thirty years later, similar sentiments continue to be expressed. Murphy (2002) argues that concepts hold our mental world together, and Bloom (2004) suggests that a creature without concepts would be unable to learn. Concepts are considered so fundamental to human cognition that Fodor (1998) asserted that "the heart of a cognitive science is its theory of concepts" (p. vii). If concepts are so important for cognitive scientists to understand, then cognitive scientists need to be able to identify relevant concepts to study. In this paper, we ask what role words can play in identifying them.

To address this question, we need a working definition of concepts. Murphy (2002) suggests that concepts are mental representations of classes of objects in the world and that they tell their holders what things there are and what properties they have. Carey (2009) indicates that concepts are units of thoughts that are the constituents of beliefs and theories. Bloom (2000) suggests that they are mental representations of kinds, and Solomon, Medin, and Lynch (1999) offer that concepts are building blocks of thought and that they have, among their functions, supporting classification, inference, and conceptual combination. Taken together, such remarks suggest that concepts are stable units of knowledge in long-term memory that represent meaningful sets of entities in the world and provide the elements out of which more complex thoughts are constructed. Although many authors using the term do not provide an explicit definition, this description seems to capture the general usage (though a few propose alternatives; see Barsalou, 1987; Smith & Samuelson, 1997; Prinz, 2002). Throughout most of this paper, this dominant approach is what we will address. In Section 3, we will revisit this use of the term and consider whether alternative ways of describing mental representations of the world may be more useful.

Among those using the general notion of concepts just described, the prevailing assumption seems to be that many important concepts can be easily identified because they are revealed by words – in fact, for many researchers, the words of English. Smith and Medin (1981) used English nouns such as *hat*, *fish*, *triangle*, *table*, and *robin* to identify concepts, as did Rosch (e.g., Rosch & Mervis, 1975; Rosch, Mervis, Gray, Johnson, & Boyes-Braem, 1976) and Lakoff

(1987). More recent investigations have continued in the same vein (e.g., Murphy, 2002; Fodor, 1998, who takes English nouns to reveal the stock of basic concepts that might be innate; and Carey, 2009, who says that the concepts that interest her are roughly the grain of single lexical items, and that representations of word meanings are paradigm examples of concepts. Even in formal and computational models, discussions of the formalisms are illustrated with examples using English nouns (e.g., Kruschke, 2005; Rogers & McClelland, 2004). And this approach has not been limited to those studying "concepts" per se. Harnad (2005) declares "kinds" to be the world's potential affordances to sensorimotor systems, but he goes on to suggest finding out what those kinds are by opening a dictionary.Work on conceptual combination has taken nouns such as *chocolate* and *bee* or *zebra* and *fish* to indicate what concepts are combined (e.g., Hampton, 1997, 2012; Wisniewski, 1996). In work on neural representation of concepts and on deficits due to brain injury or disease, "conceptual judgment" tasks often entail responding to nouns; e.g., Kable, Kan, Wilson, Thompson-Schill, & Chatterjee, 2005; Mahon & Caramazza, 2007). In cognitive development research, appeals to English nouns such as *horse*, *cow*, *boot*, and *sail* are prevalent in identifying children's concepts (e.g., Bloom, 2000; Gelman, 2006; Hills, Maouene, Maouene, Sheya, & Smith, 2009; Keil, 1989, Xu, 2005). Kelemen and Carey (2007) talk about the meaning of the word *accordion* and the concept of accordion interchangeably, and Gentner (2005) identifies relational concepts by reference to English nouns (*gift*, *weapon*, *predator*, etc.). Even discussions of visual object recognition (e.g., Ullman, 1998; Ullman, Vidal-Naquit, & Sali, 2002) and of concept representations in non-linguistic primates and pre-linguistic infants (e.g., Phillips & Santos, 2007) often identify the concepts or kinds that are to be recognized or acquired by means of English nouns.

At an intuitive level, this approach seems reasonable. After all, it makes sense to think that a person who has a grasp of the words *cat* and *chair* has concepts of cats and chairs. If entities in the world fall into natural groupings according to their shared properties – as has been argued by a number of researchers (e.g., Anderson, 1991; Berlin, 1992; Hunn, 1977; Rosch et al., 1976; Rogers & McClelland, 2004) – then it also makes sense to take English words to capture those groupings and to be associated with a coherent mental representation of those groupings. For instance, the noun *chair* will capture a set of objects sharing properties such as having a seat, a back, legs, and supporting a human in a particular position, and people will have a concept involving knowledge about this set of things. And, if the preceding points are right, there is no need for concern about the fact that it happens to be English words that are often invoked, because other languages should have words that capture essentially the same groupings and are associated with essentially the same concepts.

But from a different perspective, this approach is startling. Word meanings are highly selective in what elements of experience they encode. Because of this selectivity, there are many possible ways to map between words and the world (Wolff & Malt, 2010). Cross-linguistic research indicates that languages vary dramatically in how they carve up the world by name. Substantial cross-linguistic variation has been documented in domains including color, causality, mental states, number, body parts, containers, motion, direction, spatial relations, and terms for acts of cutting and breaking and of carrying and holding (see chapters in Malt & Wolff, 2010, for detailed illustrations; also Evans & Levinson, 2009; Gentner & Goldin-Meadow, 2003; Gumperz & Levinson, 1996; Kay, Berlin, Maffi, & Merrifield, 1997; Majid, Boster, & Bowerman, 2008; Majid, Enfield, & van Staden, 2006; Majid & Levinson, 2011; Saji, Imai, Saalbach, Zhang, Shu, & Okada, 2011, Wierzbicka, 2009, among others). As the list indicates, this variation occurs even in concrete domains labeled by nouns, where structure in the world might seem most likely to provide salient groupings that would be captured by the words of any language. For instance, papers in Majid et al. (2006) document diversity in how languages divide up the human body with body part terms, and Malt, Sloman, Gennari, Shi, & Wang (1999) found diversity in how languages divide up ordinary household containers (see also Malt, Sloman, & Gennari, 2003). *Hand* versus *arm*, *bottle* versus *jar*, or *dish* versus *plate* may seem to English-speakers to be self-evident distinctions based on obvious discontinuities in the distribution of properties in the world, but not all languages observe these same distinctions. Even when structure in the world does produce shared tendencies in meanings (e.g., the joints for body part terms, Majid, 2010), it under-determines how any given language will map words onto elements of the world. And this diversity is not only a matter of making fewer versus more distinctions. Languages often partially or substantially cross-cut each other in the sets of entities that they group together (e.g., Bowerman, 1996a, b; Malt et al., 2003). For example, whereas English speakers distinguish spatial relations of containment from support (*in* versus *on*) and ignore variations in tightness of fit or attachment to the surface, Korean speakers label relations of tight containment and attachment with one word (*kkita),* contrasting with loose containment (*nehta),* and loose support (*nohta)* (Bowerman, 1996a, b).

If the heart of a cognitive science is its theory of concepts, then the field risks serious, even fatal, defects, by overlooking the implications of this diversity. As the just cited work establishes, differences among languages are not merely cute examples for cocktail party conversation (cf. de Boinod, 2006, on "extraordinary words from around the world"). Diversity in how languages carve up the world by name is more of a rule than an exception across many domains. In light of the documented diversity, there are three logical possibilities for the nature of the relationship between words and underlying, general purpose concepts that serve as the elements out of which more complex thoughts are constructed. These possibilities have clear consequences for theories of mental representations, and for how researchers would need to look for concepts.

The first possibility is that the words of a language do effectively reveal much of the stock of basic concepts that a person holds. Importantly, given the pervasive cross-linguistic variability in naming patterns, this possibility implies that word-learning creates much of the language user's non-linguistic representations of the world (cf. Whorf, 1956). Under this scenario, it is not possible to hold that any substantial stock of basic concepts is shared across speakers of different languages. Concepts revealed by English words will be true of English speakers, those revealed by Spanish words will be true of Spanish speakers, and so on, and these language-specific sets will be substantially different from one another. Models of semantic cognition (e.g., Rogers & McClelland, 2004) would need to be taken as models of a particular language group and modified to give a larger role to names in establishing similarity among representations of entities. Under this perspective, views of conceptual development would need to grant that the end result of development is a highly language-specific set of concepts (not just word meanings), regardless of any inborn, universal systems of "core cognition" (Carey, 2009) or universal pre-linguistic sensitivities to certain conceptual distinctions (e.g., Casasola & Cohen, 2002; Gentner & Bowerman, 2009; Göksun, Hirsh-Pasek, & Golinkoff, 2010).

The second possibility is that the stock of basic, general-purpose concepts is dissociated to some notable extent from the large differences in naming patterns, and it is therefore impossible to use words to identify these concepts. After all, much learning about the world comes from direct interaction, rather than through language. Furthermore, attention to and memory for information in the world may be shaped in part by cognitive constraints (such as limits on processing capacity) and evolutionary influences (such as special sensitivity to survival-relevant information) that are independent of the language spoken (e.g., Bock, Carreiras, & Meseguer, 2012; Nairne & Pandeirada, 2008; Seligman, 1971; Willems, de Boer, de Ruiter, Noordzij, Hagoort, & Toni, 2010). Although speakers of all languages do not make the same *bottle* versus *jar* naming distinction that English speakers do (Malt et al., 1999), they are likely to note the same differences among different-sized and -shaped containers regarding their suitability for storing and extracting various types of substances. The dissociation possibility suggests that non-linguistic representations can be substantially shared despite linguistic variability, while still allowing that language could have some influence on mental representations. Under this possibility, there may be many widely shared general purpose representations. There also may be some non-linguistic representations that are shaped by the language spoken, but the shaping will not necessarily fully align the conceptual content with individual words. Crucially, if linguistic and non-linguistic representations are distinct and only loosely linked, then words are no longer direct vehicles to general-purpose concepts. The words of a language cannot routinely and straightforwardly be used to identify a person's concepts.

Empirical evidence supports a dissociation in at least some domains. Malt et al. found strong correspondence in similarity judgments for common household containers among speakers of these three languages despite distinctly different naming patterns, and Ameel, Storms, Malt, & Sloman (2005) found similar results for Belgian speakers of French versus Dutch (see also Kronenfeld, Armstrong, & Wilmoth, 1985). Also using artifacts, Saalbach and Imai (2007, 2012) found no influence of noun classifier categories on Mandarin speakers' object judgments in several tasks (although they did find a small influence in two other tasks; see also Huettig, Chen, Bowerman, & Majid, 2010). Similar findings also exist for other domains. Comparing 17 languages for color naming versus color sorting, Roberson, Davies, Corbett, and Vandervyver (2005) found considerable similarity in grouping behavior despite substantial variation in naming. Munnich, Landau, and Dosher (2001) found that Korean and English speakers' memory for spatial locations varied less than their naming of the locations (see also Coventry, Valdés, & Guijarro-Fuentes, 2010), and several studies have found dissociations between labeling of actions and attention to or memory for elements of the actions (e.g., Gennari, Sloman, Malt, & Fitch, 2002; Papafragou, Hulbert, & Trueswell, 2008; see also Sauter, LeGuen, & Haun, 2011, on similar dissociations for emotional expression). If the evidence and arguments just cited are valid, this could mean that the second possibility above is right, the first is wrong, and words must be thrown out as a way of accessing concepts.

However, a third possibility, less obvious than the first two, also exists and needs to be evaluated. This third possibility is that the relation of words to the stock of general-purpose concepts is not as straightforward as current practice has taken it to be (as also suggested in the second possibility), but still, if examined in the right way, words may reveal something useful about conceptual representations shared across speakers of different languages. By looking beyond individual words from a language as if they provide a direct route to concepts, and applying more sophisticated techniques to extract structure from individual language naming or naming aggregated across languages, it may be possible to discern shared elements of meaning that indicate constraints on cross-language variability and reflect some common underlying aspects of how knowledge of the domain is represented. In this case, words may retain utility in identifying a shared understanding of a domain. However, what they reveal may not necessarily match the traditional idea of units of knowledge representing meaningful sets of entities in the world. We consider alternative ways of thinking about conceptual representation in Section 3.

In short, linguistic diversity in naming patterns has been well-documented across many domains but it is rarely considered in the study of concepts. It has potentially profound implications for this study, but exactly what the implications are remain to be pinned down. Next, we discuss some data that evaluate different ways of tapping into the information provided by words about conceptualization of a domain and help discriminate among the three possibilities. These data illustrate what words reveal under different approaches and what an appropriate use of words is for researchers whose interest is in underlying non-linguistic representations rather than in knowledge about the word meanings of a particular language. In doing so, the data specify some key implications of linguistic diversity for the study of concepts.

1.3 Additional Considerations

Before turning to this illustration, we note two points about past treatment of the relation of words to concepts in the literature.

First, some, or perhaps many, researchers who use words of English (or another language) to point to concepts may only be using the words as convenient shorthand. They do not necessarily have an explicit commitment to a strong Whorfian position regarding the alignment of words and the stock of basic, general-purpose concepts. However, being non-committal on the issue is problematic once the pervasive cross-linguistic diversity in naming patterns is recognized. Either words must largely determine these concepts, or they cannot serve as useful shorthands for them. If the second is true, a separate account is needed of what constitutes these concepts and how they can be identified. Some researchers may also hold a somewhat more nuanced view of the word-concept relation. For instance, Murphy (2002), despite using English words to identify concepts throughout most of his book, argues in a chapter on word meaning that word meanings do not always have a simple one-to-one relation to concepts and that meanings may be composed of a part of a concept or built out of multiple ones. If taken as his real position, this leaves Murphy the problem of how to identify what the more basic, general-purpose concepts actually are – an odd dilemma in a book that is primarily about concepts. Rogers and McClelland (2004) provide their own answer to what the concepts are. Echoing Rosch and Mervis (1975) and others, they take the correlational structure of the world to provide the ultimate answer, with mental representations of objects clustering based on similarity of properties. However, their inferences about what the similarity relations are come only from considering English nouns. They assume that the correlational structure of the world produces concepts corresponding to *chair*, *table*, etc. They do not provide any independent means of verifying either structure in the world or conceptual structure – again, problematic without a commitment to the alignment of words and concepts (cf. Majid & Huettig, 2008).

Second, there is one sense of the term *concept* in which it must be true that the words of a language effectively reveal the concepts held by its speakers. That is when *concept* is used to mean the knowledge associated with words. In this sense, if English *bottle* is applied to a somewhat different set of objects and carries somewhat different featural implications than Spanish *botella* (Malt et al., 1999, 2003), then English and Spanish speakers have acquired somewhat different concepts. To the extent that the goal of concept researchers is to study exactly those chunks of knowledge encoded by the words of a particular language (lexicalized concepts), there is nothing wrong with using words to identify the knowledge to be studied.

But there are several reasons why studying the knowledge associated with words is not sufficient for understanding conceptual representation more broadly. First, if lexicalized concepts are taken as constituting the main set of general-purpose concepts that cognitive scientists should know about, then this approach functionally makes elements of language – word meanings – the primary medium of thought, whereas cognitive scientists generally accept that there is a medium in which thought takes place that is distinct from any language used for external communication (Fodor, 1975). Second, by taking word meanings to reveal the stock of basic concepts used in more complex thought, it commits cognitive science *a priori* to a strong version of the Whorfian hypothesis in which it is language that creates that stock of concepts. Finally, cognitive scientists who use words to identify concepts most often seem to actually have a different goal than the goal of understanding the knowledge associated with words of a specific language. Rosch (Rosch & Mervis, 1975; Rosch et al., 1976) explicitly contrasted the view that segmentation of the world is arbitrary with her own hypothesis that the world contains inherent structure ready to be recognized by human perceivers. Keil (1989) appealed to "causal homeostasis", suggesting that concepts (in at least some domains) are formed in recognition of networks of properties in the world that are causally connected to one another. More recently, as just noted, Rogers and McClelland (2004) appeal to structure in the world as the determinant of conceptual content. Bloom (2004) argues at some length that language is a tool for thought but is not the mechanism that gives rise to the capacity to generate and appreciate ideas in the first place. If word meanings may be composed of a part of a concept or built out of multiple ones (Murphy, 2002; see also Clark, 1983), likewise, some more basic stock of conceptual elements must be the building blocks of word meaning. Furthermore, any researcher interested in the possibility of innate concepts, along with those who aim to study concepts in non-linguistic primates or in pre-linguistic infants, must be seeking ones that are not created by learning of words of a language. Much of the time, then, concepts researchers seem to have a goal of studying representations that are not created by language, even while using the words of one particular language to find them.

In sum, our goal is not to argue against the idea that words may gain meaning by association with conceptual content. Nor are we arguing that the content associated with a word cannot be called a lexicalized concept. Our concern is with what role words can play in identifying concepts in the sense of general-purpose representations that are not inherently part of linguistic knowledge.

2. A Case Study: Words for Human Locomotion

We now turn to some data on naming patterns for English, Dutch, Spanish, and Japanese for forms of human locomotion (walking, running, skipping, hopping, and so on). Humans around the world are capable of the same forms of locomotion regardless of location or culture, suggesting that there may be substantial shared elements of their understanding of this domain. At the same time, based on previous data for a more limited sample of locomotion stimuli (produced on a treadmill that varied in speed and slope; Malt, Gennari, Imai, Ameel, Tsuda, & Majid, 2008) we had reason to expect some diversity in naming patterns. This domain therefore provides a useful case study of the relation of naming patterns to conceptualization. The stimuli were 36 video clips, 3-4 seconds in length, depicting upright, bipedal human locomotion of as wide a variety as we could generate. All actions were demonstrated by an American college student. Fig. 1 shows sample frames from four clips.

[insert Fig. 1 about here]

To determine the names each language has for the range of human locomotion depicted, we asked native speakers of the four languages, mostly undergraduates or graduate students resident in their home countries, to look at each clip and name it. Participants viewed the clips embedded in a web page and for each one, answered the question "What is the woman doing? She is…." or its translation in the appropriate language. More details of the methods, as well as analyses not discussed here, can be found in Malt et al. (2013). Here, we consider the sets of names produced in each language, how names are distributed across actions within each language, and whether there are shared patterns in this distribution across languages. For each analysis, we consider the implications for understanding how words may relate to concepts.

2.1 Name inventories

We first determined the set of names that were used in each language for these actions. This analysis is most like the usual approach of concept researchers, except that the standard approach stops with a single language and does not compare the results with what other languages would suggest. We asked whether the different languages show consensus on what these concepts would be.

There was diversity in the surface form people used in their responses. For instance, for a given clip, in English, many participants might have said that the woman is *walking* but a few might have said *doing a walk* and some even said just *walks* or *a walk*. Some may also have said that the woman is *walking slowly*, or *walking fast with her arms swinging*. We counted as an instance of the same name all surface forms containing the same root word(s) labeling a manner of movement, and we tallied these names for each clip to determine the frequency of names produced across the participants. We considered each clip's "dominant" name to be whatever word was produced most often across the participants in the language group. Clips for which fewer than 30% of respondents agreed on a name were considered "mixed".

It is worth considering first what concepts would be identified by simple, single morpheme words. These words are most like the ones generally considered to pick out basic-level concepts in the psychological literature (e.g., Murphy, 1988; Rosch & Mervis, 1975). The mono-morphemic words that emerged as dominant for at least one film clip in a language are given in Table 1[2]. This tally makes clear that if there are universally shared concepts of this domain, these words do not directly reveal what they are. The different languages provide different answers about what that set would be.

[insert Table 1 about here]

There are also arguments for seeing if conventional names that have more than one morpheme can help reveal the most basic concepts. Brown (1958) observed that when people name at the "level of usual utility", that name is occasionally longer than a less-used name. For instance, a certain fruit is more likely to be called *strawberry* than *fruit*. A small number of Rosch et al.'s (1976) "basic level" terms were of this nature (e.g., *screwdriver*, *airplane*). Furthermore, across languages, the same notion may be expressed in different forms: A male child in English is mono-morphemic *boy*, but in Yucatec, it is *xi'pal*, containing morphemes for male and for child, and in Spanish, it is *muchacho* (or *niño*), a single root with a masculine suffix (Lucy, 2010). Along those lines, for speakers of Japanese, limiting consideration to simple, mono-morphemic responses risks excluding some common action labels. Japanese speakers use a construction consisting of an action noun plus the light verb *suru* ('do') to refer to some actions. Such phrases are similar to English *doing a jump* or *doing a march step*, except that some are fixed, conventional, and common labels for actions. Boldfaced names in Table 1 are those added under this version of the tally. Under this count, the Japanese number of unique names is similar to that for Spanish, but both remain below the level of English and Dutch. The basic observations from before remain intact. The languages differ markedly in the inventory of names they display for this domain, and so names do not identify a universal set of shared concepts.

Could the speakers really vary so much in their concepts of this domain? And could they really lack concepts of some of the actions, as suggested by the clips designated *mixed*, for which there is no agreed-upon name? For instance, do Japanese speakers lack a concept of running in place that the other speakers have? The remaining analyses help address this question, but for now we note that it seems unlikely that American and Belgian traditions or current lifestyles lead individuals to develop more highly differentiated locomotion concepts, overall, than Argentinean and Japanese experiences do. If there are differences in the conceptual inventory as large as is suggested by the naming difference, it seems they must be directly created by the language differences, in line with the strongest form of a Whorfian perspective.

However, a glance at the entire phrases participants produced show that speakers of all the languages are, in various ways, making many more distinctions among the actions than those reflected in the conventional names. For instance, Spanish speakers often used modifiers to discriminate among cases of *saltar* done on one foot versus two (*hop* versus *jump* for English speakers), and speakers of all the languages used location modifiers to point out the actions done in place. This observation suggests that people may have concepts important to the domain that are not captured in a single word. In the anthropological literature, it has been noted that many languages lack labels equivalent to English *plant* and *animal*, as well as for some groupings within these kingdoms, but the groupings still seem to be recognized as indicated by various non-verbal behaviors (e.g., Berlin, 1992). If a similar situation holds here, then, again, we have to conclude that words are a poor indicator of where the concepts of interest lie (even if modest cultural differences do exist among the groups).

This first analysis points out the fundamental problem of taking individual words of any one language to directly reveal concepts: Different languages will give different answers to what the concepts are, and these linguistic differences are likely to exceed the extent of any conceptual differences. We now ask whether other ways of examining the naming data do a better job at uncovering shared concepts. To the extent that they do, the results will underscore the fallacy of treating the individual words as if they directly reveal concepts. At the same time, they will suggest that naming data, examined in an appropriate way, may still provide some evidence of a shared understanding of the domain.

2.2 Treating Individual Languages' Naming as Similarity Data

In this analysis, we asked whether commonalities emerge from the naming data of the four languages if we make use of the full set of names produced by all participants for all stimuli. Many clips did not produce 100% name consensus within a language group, so even if one language has different dominant names for two clips (e.g., *walk* and *stroll*), and another gives them the same name (e.g., *caminar*), some speakers of the first language may have produced the same name for both (e.g., *walk*), pointing to a perceived similarity between them. We created name similarity matrices that reflect the extent to which each pair of objects received the same name across the speakers of a language. To do this, we assigned, for each participant, a 0 or a 1 to each possible pair of clips according to whether the person gave the two clips a different name or the same name (again, tallied according to the guidelines described above). There are 630 such pairs, given the 36 clips. We then constructed a similarity matrix for each language group by summing the distance values for each of the 630 pairs of clips across the participants in that language group. This use of the data is similar to using confusion matrices as similarity data (e.g., Rothkopf, 1957; Shepard & Chang, 1963). By taking into account the full naming array for each clip and applying scaling techniques to the similarity matrices, commonalities among languages may become more evident.

We correlated the name similarity matrices for each pair of languages to give an overall sense of the correspondence in the naming patterns, using the Mantel test for correlation of matrices (Mantel, 1967). These correlations are all significant, falling between .65 and .82. The correlations indicate that the full patterns of name use, while diverse, still share some substantial commonalities.

We then carried out multi-dimensional scaling on the matrix for each language (procedure MDS, SAS Institute, 1999). To help interpret the results, Additive tree clusters were drawn on the solutions (Corter, 1982; Sattath & Tversky, 1977). Solutions for the four languages are shown in Figs. 2 – 5, with only the top two levels of clusters for ease of viewing. Labels in the solution refer to the clip names bestowed by the experimenters (not the name given by participants) so that the solutions can be compared with regard to which clips are grouped together across the languages.

[insert Figs. 2-5 about here]

These solutions, while showing similarities, also highlight important differences. For all four languages, the horizontal dimension is interpretable in terms of the basic biomechanical distinction between an elastic impact-and-recoil motion (characteristic of running gaits and others such as hopping and jumping) and a pendulum motion (characteristic of walking gaits), where one foot is on the ground at all times (e.g., Alexander, 2002; Bennett, 1992). (The pendulum-based gaits appear toward the left-hand side of each solution and the impact-and-recoil toward the right.) However, the exact spatial layout of clips varies considerably across the languages. The vertical dimension for the most part seems to reflect a dimension of speed and/or aggressiveness (with slower/less aggressive actions lower and faster/more aggressive ones higher for English and Spanish and vice versa for Dutch), but the Japanese solution less clearly conforms to this possibility. The clusters resulting from the Addtree analysis reinforce the idea that the biomechanical distinction is salient for two of the languages – Dutch and Japanese – which have top-level clusters separating essentially the same sets of clips (though Dutch places the RUN_FAST clip just into the cluster of pendulum motions). English and Spanish clusters are less like the Dutch and Japanese results: for English, running actions cluster with pendulum motions at the top level, and for Spanish, walking backwards and several forms of marching combine with impact-and-recoil motions, as well as walking in place. In the next level of clusters within these top-level clusters, each language more or less separates the faster/more aggressive pendulum actions from slower, more cautious pendulum actions, but the exact composition of the clusters is variable. The Dutch solution, in particular, does not honor this separation as much as the others.

These solutions indicate that the naming patterns of the four languages reflect a shared orientation to the same dimensions of the movements. This outcome supports the idea that speakers of the four languages may have more in common in their perception of the domain than their name inventories indicate. In light of the variability of the Addtree clusters across the four solutions, though, it remains difficult to say exactly what could be identified as shared discrete concepts in the traditional sense.

2.3 Treating Aggregated Naming as Similarity Data

Last, we created a multi-dimensional scaling solution combining the naming data of participants in all four language groups. MDS by its nature looks for commonalities in the data, and to the extent that it finds them, produces a coherent solution. If a coherent solution emerges, this result would again support the idea of a shared conceptualization of the domain while underscoring the inadequacy of individual words of a single language to reveal it. Compatible with this possibility, Regier, Kay, and Khetarpal (2007) examined the highly variable color terms across 110 languages and found evidence for a general well-formedness constraint of maximizing similarity within lexical categories and minimizing it across categories. Khetarpal, Majid, and Regier (2009) obtained similar results for spatial terms of nine languages. More similar to the current analysis, Majid et al. (2008) aggregated across 28 languages' verbs for cutting and breaking and found a shared set of dimensions underlying the different naming patterns. With only four languages to combine here, our data provide less to aggregate, but the smaller sample of languages is more like that typically available to psychologists working on concepts. From that perspective, it is particularly useful to see if a coherent conceptual space emerges from the data of only four languages.

We carried out multi-dimensional scaling as before. Fig. 6 shows the two-dimensional solution, with clusters again provided by Addtree. This solution shows a neat horizontal separation of the impact-and-recoil motions (toward the right) from the pendulum motions (toward the left). The vertical dimension again appears to reflect something like speed and aggressiveness of the actions, with slower/less aggressive actions toward the top and faster/more aggressive ones toward the bottom.

[insert Fig. 6 about here]

At the top level of clustering, the impact-and-recoil motions are separated from the pendulum-based ones, with the exception of the TROT clip falling into the pendulum cluster. The placement of the TROT clip is most likely because of the qualities of the particular action implemented in the clip, which was a bouncy motion but with little or no evidence of both feet being off the ground at the same time. Within these clusters, sub-clusters separate the running clips from the other impact-and-recoil actions, and separate the true pendulum motion clips from the intermediate TROT clip. These clusters are thus readily interpretable, although they do not seem to map directly onto the words of any of the languages.

So, the naming data when aggregated across the four languages provides more indication of a systematic conceptual space than looking at scaling solutions of the four languages individually does. This shared space emerges out of the noisiness of the individual name inventories, which make different distinctions and numbers of distinctions. Because MDS can discover commonalities in data but it cannot invent them, the simplicity of the solution is evidence in favor of a shared underlying understanding of the domain. At the same time, though, if the clusters identified by Addtree are taken to indicate discrete concepts within this space, they do not seem to be picked out by words of the languages. This outcome again suggests a shared conceptualization of the domain that is not revealed by the words of any single language.

2.4 Conclusions from Using Names to Reveal Conceptual Space

These analyses demonstrate that languages differ in what their name inventories would tell us the concepts for the domain are. If there are shared general-purpose concepts, then the words of any one language do not directly reveal what they are. Moreover, different ways of counting names (mono-morphemic only versus including multi-morphemic ones) produce somewhat different answers. Even if we were to adopt a strong version of the Whorfian hypothesis and assume that words of a language do directly reveal basic concepts for speakers of that language, it is not clear which way of counting would be the right one to use, and using names as direct pointers to concepts would remain problematic.

Despite the diversity in the name inventories, other ways of analyzing the data show commonalities underlying the naming patterns. In particular, scaling of the combined naming data of four languages produces a coherent and interpretable solution, suggesting a shared orientation to certain dimensions of the space. Still, the clusters within the scaling solution do not neatly correspond to those labeled by the names of the languages, raising questions about what, if anything, can be identified as discrete concepts in the traditional sense.

3. Issues and Implications

3.1 Implications for the Status Quo

The data make a strong case that the relation of words to concepts is not straightforward. Pervasive linguistic diversity, amply documented in other research but rarely taken into consideration within "concepts" research, is by itself cause for serious concern. It would still be possible to preserve a commitment to word-concept alignment by subscribing to a strong version of the Whorfian idea that language shapes thought. However, the evidence here from aggregated naming suggests that any conceptual differences are less than implied by the differences in word inventories. This evidence is also consistent with past findings in other domains and the observation that attention to and understanding of aspects of the world are likely shaped by multiple forces that may include but are not limited to language (see Section 1.2). It seems unavoidable to conclude that researchers need to stop relying on the word inventories of English, or any other single language, to know what constitutes the concepts of a domain.

In light of our data and arguments, what should be made of the existing literature on concepts? We suggest that what is being studied in many cases – those where probing of knowledge comes in the form of asking for responses of various sorts to the words of English or another language – is people's knowledge associated with the words. There is nothing wrong with investigating knowledge associated with words, and making this clarification does not cast doubt on the value of the work. It does, however, suggest the need to reframe the understanding of what the work reveals, because this methodology does not directly shed light on general-purpose non-linguistic concepts, possibly shared across speakers of different languages. The only alternative is for the researcher to cast the work as directly investigating non-linguistic concepts by making an explicit commitment to a strong version of a Whorfian perspective and defending this perspective. Whichever approach the researcher takes, it should always take into account the existing pervasive cross-linguistic diversity and the fact that word inventories can only be used as the means of tapping units of knowledge by committing to the notion that the units accessed are language-specific.

It might be possible to argue for a direct alignment of words with general-purpose concepts for some domains on the grounds that in certain domains, word meanings should be broadly shared across speakers of different languages. Such word meanings could be hypothesized to exist for any innate concepts, and for concepts that are developed in a similar way across cultures due to cross-cultural recognition of structure in the world. A logistical complication still arises in that the existence of the broadly shared word meanings cannot be assumed; it would have to be verified by careful cross-linguistic comparison for a domain of interest. An empirical complication also arises in that in many such domains where cross-linguistic data have been examined, word meanings have turned out to be more variable than previously imagined. Even though substantial elements of the human experience of sensory input, emotion, or space, for instance, might be universal (e.g., Clark, 1973; Ekman, 1992; Henning, 1916), recent investigations have shown that sensory vocabularies (Majid & Levinson, 2011), emotion terms (e.g., Wierzbicka, 1999, 2009) and spatial term inventories and meanings (Bowerman, 1996a, b) are considerably variable across languages. Perception of the body or of human locomotion might be heavily constrained by structure in the stimulus domain (body joints or biomechanics of movement), but the current work and our earlier work (Majid et al., 2006; Malt et al., 2008) has shown cross-linguistic diversity in these domains, too. The body part and locomotion work does show that alongside diversity, the structural constraints are reflected in shared elements of meaning. However, it seems impossible to discern from only a single language what the shared elements will be and which parts of the patterns are idiosyncratic to the language.

The domain of natural kinds is another for which it has been argued that structure in the world will give rise to shared elements of meaning (Berlin, 1992; Hunn, 1977) – in this case, the structure being clusters of correlated properties separating scientific genera such as bovines versus equines. Berlin (1992), Hunn (1977) and others (see Malt, 1995, for review) document that non-industrialized cultures tend to recognize by name much the same sorts of groupings that modern science and more technologically advanced cultures do. But again, the broad similarities are accompanied by differences. Primary names that label rich, important, frequently used conceptual content for members of traditional societies sometimes point to highly impoverished representations for members of urban societies (such as *elm* versus *oak* versus *chestnut*; Dougherty, 1978; Wolff, Medin, & Pankratz, 1999) due to attrition of knowledge bases over cultural time. Conversely, some significant groupings may lack labels in various languages, as in the case of labels for plants versus animals mentioned earlier, as well as groupings within them that are appreciated but of lesser cultural utility (see Malt, 1995, for review). Furthermore, although many groupings labeled with primary names may reflect structure in the world, some may depend on properties such as domesticity or use. In fact, many English names for familiar naturally occurring entities pick out groupings based on their role in human lives rather than biology, e.g., *weed*, *tree*, *vegetable, dog* (see Malt, 1991) and so do not reflect world structure of the sort argued to produce cross-linguistic similarities. Most likely, the degree to which words of a single language can directly reveal shared concepts for a domain for speakers of different languages will fall on a continuum from poor to better (but still imperfect). The cases just discussed indicate that it may not be possible to discern what is poor and what is better without detailed empirical study.

Despite the complex nature of the relationship between language and general-purpose concepts, our data suggest that it is still possible to use linguistic data to gain insight into something more fundamental about the nature of conceptual space. That is, combining naming information across languages does seem to provide useful information, because the aggregate allows commonalities to emerge over the “noise” of individual language idiosyncracies. Sometimes naming data are more readily available for researchers than data such as similarity judgments. This is particularly true for those already in a position to collect data from members of different language communities through simple paper and pencil tasks, or who have access to archived data on naming for domains of interest. However, it is clear that there are also methodological challenges involved in collecting naming data across languages, in particular, gaining access to participants who speak diverse languages, and having available the language expertise to administer tasks and interpret data from the various languages. For researchers whose usual methodologies entail only members of one language group, obtaining such cross-linguistic data may not be feasible. In those cases, developing other methods of avoiding the problem of faulty reliance on a word-concept equivalence will be crucial, such as finding ways to implement measures less dependent on language.

3.2 If there is a Shared Conceptual Space, Why don't Individual Naming Patterns Align Better?

The possibility of a significant dissociation of naming patterns from how people understand a domain non-linguistically raises the question of why languages diverge in their naming patterns in the first place. If there are shared experiences across cultures in at least some domains, why wouldn't the naming patterns for those domains align more closely? The answer most likely lies in the facts that (a) words encode only a fraction of the richness of experience and (b) the meanings encoded in any particular set are shaped in part by forces independent of the conceptual representations of current speakers. Some elements of arbitrariness in the early development of a set of meanings will exist, simply because of the limitation on how much words can encode. As the language continues to evolve, external forces such as contact with other languages, waxing or waning of the importance of a domain to the culture, the introduction of new entities within the domain that need to be named and the order in which they enter the culture, and influences from the syntax and morphology of language on how distinctions can be expressed, can alter the set of words available in a domain and the meanings associated with each word (e.g., Aitchinson, 2001; see Malt et al., 2010 for discussion). Because each language evolves on its own path, and the current state of a language is always a function, in part, of past states (e.g., Dunn, Greenhill, Levinson, & Gray, 2011), languages will develop their own patterns of naming that may be only loosely related to one another, as well as only loosely related to current ways of thinking about the world by their speakers.

3.3 Implications for Property Projection

Promoting inferences has been taken to be a critical benefit of putting names on things (e.g., Gelman & Markman, 1986; Heit, 2000; Osherson, Smith, Wilkie, Lopez, & Shafir, 1990; Quine, 1970). The partially arbitrary nature of linguistic categories highlights the fact that inferences will not always be well-circumscribed by named categories. For instance, consider the English names *chair, knife,* and *spoon*. A beach chair is light but an armchair is heavy; a desk chair has a rigid seat but a beanbag chair does not; a kitchen chair may be wood and a folding chair metal. A kitchen knife is intended for cutting but a frosting knife for spreading; a soup spoon is for scooping up liquids but a slotted spoon for draining them; a hair brush is for smoothing but a scrub brush is for scrubbing. This imperfect matching of properties to names is not limited to artifacts: Although chihuahuas and Siberian huskies share the property of domesticity that projects across things called *dog*, other properties such as size, strength, home (small or large, indoors or out) and ability to withstand cold may be more shared with things called *cat* or *wolf*. Relying heavily on names to make inferences, then, might often produce results that would turn out to be inaccurate. To the extent that inferences about unseen properties are accurate, they may be made by projecting on the basis of observed commonalities with familiar instances more often than is generally acknowledged (see also Gelman & Davidson, 1990). Despite Rogers and McClelland's (2004) problematic use of English words to identify concepts, their model provides a useful demonstration of how such inferences can be drawn without an explicit process of categorization intervening between perception of an entity and property projection.

3.4 Implications for the Notion of "Concepts"

The combined naming data from the four languages produces a fairly interpretable scaling solution suggesting that naming is driven by some fundamentally shared understanding of the characteristics of human locomotion. Different languages may make different numbers of distinctions and vary somewhat in what kinds of distinctions are being made, but they may seem to be drawing on a shared pool of dimensions. Similar observations have been made for other domains (e.g., Jones, 2010; Majid et al., 2008; see also Slobin, 2010, on locomotion). Yet the scaling solutions, while suggesting some shared understanding of the domain across speakers of different languages, and some salient groupings of instances, still leave it unclear exactly what units of knowledge should count as the most fundamental, basic concepts of the domain. Different levels of the cluster analysis produce different potential answers.

The difficulty of specifying exactly what constitute the basic concepts suggests that it may be time for psychologists to more radically rethink conceptual understanding of a domain. Despite the widespread claims that cognition centrally involves concepts, it is hard to pin down a satisfying definition of what they are. The attempts that we cited at the outset of this paper by Murphy (2002), Carey (2009), and others in entire books on the topic are somewhat vague. In a review of research on concepts and categories, Medin and Rips (2005) comment that "The concept of concepts is difficult to define, but no one doubts that concepts are fundamental to mental life and human communication" (p. 37). Smith and Medin (1981), in their seminal book that spurred much subsequent use of the term, never provided an explicit definition of what concepts are. Authors of textbooks for cognitive psychology have similar difficulties. For instance, Benjafield (2007), in a section entitled "What are concepts?" offers only that when people see something as belonging to a category, they are using a concept. Some widely-used textbooks have abandoned chapters on concepts altogether in favor of discussing the contents of knowledge representations without reference to the term *concept* (e.g., Goldstein, 2005; Willingham, 2007). It is an unsatisfactory situation when researchers believe that something is fundamental to mental life but they cannot articulate exactly what that something is.

One alternative approach to understanding where shared elements of mental representation are to be found is represented by the search for smaller units of knowledge that are primitives or "meaning-moles" such as EVENT, STATE, THING, PATH, PLACE, GOAL, MEANS, and END, etc. (e.g., Jackendoff, 1990; Landau & Jackendoff, 1993; Schank & Abelson, 1977; Slobin, 1996b; and Talmy, 1985; see Pinker, 2007)[3]. Although psychologists interested in concepts have not looked very much in this direction in the past, more attention to this approach is emerging (e.g., Aguiar & Baillargeon, 2002; Feist, 2008; Göksun et al., 2010; Parish-Morris, Pruden, Ma, Hirsh-Pasek, & Golinkoff, 2010; Slobin, 2010). For instance, researchers interested in causal verbs propose that basic notions such as CAUSE, ENABLE, and PREVENT underlie the semantics of diverse verbs in various languages (e.g., Wolff, Klettke, Ventura, & Song, 2005). Researchers interested in the acquisition of spatial terms have suggested notions such as CONTACT, CONTAINMENT, and SUPPORT as components of meaning (e.g., Bowerman, 1996a, b; Choi & Bowerman, 1991). Dimensions rather than individual features (such as reversibility of an action or predictability of the outcome of an action, as suggested by Majid et al., 2008, for verbs of cutting and breaking) may also be relevant types of elements. These postulated shared elements are generally more "primitive", in the sense of isolating single properties or dimensions, than those thought of as concepts by mainstream concepts researchers and others who draw from this tradition.

Our scaling and clustering analyses suggest perceived dimensions of gait space that can contribute to this set of units of knowledge. In fact, this sort of more fine-grained breakdown of knowledge is implied by the connectionist approach to modeling cognition (despite the tendency to label the inputs and outputs with words of a language). As Smolenksy (1988) and others have emphasized, connectionist networks are “subsymbolic” in that the features the system uncovers, constituting its learned knowledge base, are more subtle than those labeled by many words of a human language[4]. Perhaps it is at this level of analysis that the term *concept* can be most meaningfully applied.

In this type of approach, the goal is not to identify discrete, bounded, and stable units of knowledge stored in long-term memory. As such, concerns about failure to find defining features associated with fixed categories that were raised in the early backlash against classical views of concepts and compositional approaches to word meaning (e.g., Lakoff, 1987; Smith & Medin, 1981) do not apply. Instead, the dimensions of experience to which people attend under various circumstances are the key point of interest. This approach is consistent with some minority views on concepts (e.g., Barsalou, 1987; Imai & Saalbach, 2010; Malt & Sloman, 2007; Smith & Samuelson, 1997; Sloman & Malt, 2003) according to which the particular dimensions of focus vary depending on the context and the goals at hand. According to this perspective, what is brought to mind and experienced as a coherent grouping varies across experiences due to differing task demands. For instance, our similarity judgment task directed participants to focus attention on certain elements of the actions, but it is possible that under other circumstances their attentional weight to various elements would have differed. When language is engaged in a task, it will require attention to the elements of a scene that are necessary for using the words of the language to be spoken, directing attention to features that may differ from when a different language is used or no language is used (e.g., Papafragou et al., 2008; Papafragou, Massey, & Gleitman, 2006; Slobin, 1996a; see also Davidoff, Goldstein, Tharp, Wakui, & Fagot, 2012; Roberson & Davidoff, 2000; and Webster & Kay, 2012 in the domain of color). Thus speakers of different languages may activate similar representations under some circumstances and different ones under others. Regardless, the key point here is that the representations are flexibly utilized and differ from situation to situation. The variability of attention to features of a situation is supported by recent brain imaging data showing that even in simple motion perception events, different brain regions may be activated by instructions to judge different aspects of the event (e.g., Büchel, Josephs, Rees, Turner, Frith, & Friston, 1998; Raymond, 2000). It seems impossible to identify a single task that would unambiguously be the right one to decide what the discrete and stable concepts are for the domain.

This sort of more “primitive”-oriented description of conceptual space has so far been applied mainly to actions of various sorts and spatial relations. If thought of in terms of dimensions, not just “meaning-moles”, then it seems suitable for describing artifact conceptual representations as well, with relevant dimensions likely to include both physical attributes such as material and shape and affordance- or intention-related ones such as current or potential function. In fact, given the high property diversity among objects that can share a name and the tendency for objects to be scattered with only partial clustering in similarity space (Malt et al., 1999), this sort of approach may be well suited to this object domain. Exactly how well it can work for natural kinds, and what sorts of dimensions of conceptual space would be involved for them, remains to be worked out. Given the importance of beliefs about hidden essences in conceptualization of natural kinds (e.g., Keil, 1989), it will be important to consider how such beliefs can be incorporated. More abstract domains such as emotions or truth and beauty will also be a challenge for this kind of approach, but they are no less a challenge under more traditional approaches. Assuming that there are concepts called *happiness* or *truth* does nothing to specify the contents of the representations.

3.5 Future Directions

The preceding points suggest several avenues for researchers to pursue, including extending a conceptual primitives or meaning-mole approach to additional domains and more fully understanding what elements of knowledge are activated in different task contexts. For the first of these, we have argued for the use of cross-linguistic data as one means of uncovering underlying conceptual dimensions of a domain. Development of other methodologies would also be valuable. Because paradigms for research on young infants cannot rely on linguistic stimuli or responses, work on early cognitive development that seeks conceptual primitives or studies "core cognition" (e.g., Carey, 2009; Cisbra et al., 2003; Kinzler & Spelke, 2007; Spelke, 1994) may provide some useful models for work with older children and adults (see also Kalénine, Mirman, Middleton, & Buxbaum, 2012, on the use of eye movements to evaluate activation of different types of property representations).

But acknowledging a problem is always the first necessary step to solving it, and as our opening discussion illustrated, there is currently insufficient sensitivity to the problem of assuming a close alignment of words of a given language with concepts. Much of the original problem is likely due to the predominance of monolingual English-speaking researchers in the early decades of Cognitive Science. Cognitive Science is rapidly become a more international pursuit. One consequence is the participation of researchers who speak other native languages, often accompanied by proficiency in English. Along with this shift in researcher demographics has been an information technology revolution resulting in the growth of international collaborations as well as greater access to participant populations outside of English-speaking parts of the world. These changes will inevitably make linguistic variation more salient in theoretical considerations, while at the same time making research across languages more feasible.

An arena where cross-linguistic variability has already come to prominence is in the study of the acquisition and use of word knowledge by bilinguals. Initial concerns for cross-linguistic variability in word meaning focused on words for abstract ideas and culture-dependent construals of aspects of the world. However, researchers more recently have begun to look at the impact of non-equivalences of concrete nouns on bilingual word knowledge (e.g., Ameel et al., 2005; Gathercole & Moawad, 2010). This work highlights the issues we have raised here by proposing language-specific patterns of links from encoded features to words of each language (Ameel et al., 2005). A second arena is the renewed interest in the potential influence of language on thought. As we discussed earlier, cross-linguistic variability carries strong implication for assumptions about universality of concepts if concepts are taken to be revealed by the words of a single language. Attention to the Whorfian hypothesis prods researchers to come terms with the facts that if they assume word-concept equivalence, the concepts identified must be language-specific. If they do not want to study language-specific concepts, they must find methodologies that do not rely on this assumption.

3.6 Conclusion

If the heart of a cognitive science is its theory of concepts, then cognitive scientists need to re-think how to find the concepts they want to understand. Pervasive diversity in how languages carve up the world by name is well-documented but has been given little consideration in the study of concepts. Once this diversity is recognized, it creates serious challenges to business as usual. The study of locomotion presented here examined what different ways of using words to access concepts suggest about the word-concept relationship. The data show that individual words such as *walk*, *run*, and *jump*, and by implication *triangle*, *table*, and *robin*, do not directly reveal units of knowledge compatible with prevailing notions of concepts. However, more sophisticated techniques can extract structure from language data and identify shared elements of meaning. These elements indicate constraints on cross-language variability and reflect common underlying components of domain knowledge. In doing so, they may suggest useful alternative approaches to the study of conceptual representation.

Author Note

This work was supported in part by the Max Planck Gesellschaft, the Japanese Ministry of Education grant-in-aid for Scientific Research (#15300088), and research grants from Keio University (Keio Gijuku Academic Development Funds and Keio Gijuku Mori Memorial Research Fund). Eef Ameel was supported on a postdoctoral fellowship by the Fund for Scientific Research-Flanders (FWO-Vlaanderen). We thank Dan Slobin for helpful comments on an earlier draft and Adam Darlow, Kiri Lee, Yo Matsumoto, Kyoko Ohara, Steven Sloman, and Phillip Wolff for useful discussion. Kristine Schuster and Hiroyuki Okada developed the web experiment for data collection and Stephanie Sterrett served as walkway actor. Ludy Cilissen, Lisa Guest, Celina Hayes, and Erin Howard assisted with data collection and analysis.

An earlier analysis of some of the data discussed here was reported in Malt, B.C., Gennari, S., and Imai, M. (2010). Lexicalization patterns and the world-to-words mapping. In B.C. Malt and P. Wolff (Eds.), *Words and the mind: How words capture human experience* (pp. 29-57). New York: Oxford University Press. Additional analyses are reported in Malt, B.C., Gennari, S., Imai, M., Ameel, E., Saji, N., & Majid, A. (2013). Human locomotion in languages: Constraints on moving and meaning (under review).

References

Aguiar, A., & Baillargeon, R. (2002). Developments in young infants' reasoning about occluded objects. *Cognitive Psychology*, *45*, 267–336.

Aitchinson, J. (2001). *Language change: Decay or progress? (3rd Edition)*. Cambridge: Cambridge University Press.

Alexander, R. M. (2002). *Principles of animal locomotion*. Princeton: Princeton University Press.

Ameel, E., Storms, G., Malt, B.C., and Sloman, S. A. (2005). How bilinguals solve the naming problem. *Journal of Memory and Language*, *53*, 60-80.

Anderson, J. R. (1991). The adaptive nature of human categorization. *Psychological Review*, *98*, 409-429.

Ameel, E., Storms, G., Malt, B. C., & Sloman, S. A. (2005). How bilinguals solve the naming problem. *Journal of Memory and Language*, *53*, 60-80.

Barsalou, L. W. (1987). The instability of graded structure: Implications for the nature of concepts. In U. Neisser, ed., *Concepts and conceptual development: Ecological and intellectual factors in categorization (pp. 101-140)*. Cambridge: Cambridge University Press.

Benjafield, J. G. (2007). *Cognition (3rd Edition)*. Oxford: Oxford University Press.

Bennett, M.B. (1992). Empirical studies of walking and running. In R. McN. Alexander (Ed.), *Comparative and environmental physiology, vol. 11: Mechanics of animal locomotion* (pp. 141–165). Berlin: Springer-Verlag.

Berlin, B. (1992). *Ethnobiological classification: Principles of categorization of plants and animals in traditional societies*. Princeton, NJ: Princeton University Press.

Bloom, P. (2000). *How children learn the meanings of words*. Cambridge, MA: MIT Press.

Bloom, P. (2004). *Descartes' baby: How the science of child development explains what makes us human*. New York: Basic Books.

Bock, J.K., Carreiras, M., & Meseguer, E. (2012). Number meaning and number grammar in English and Spanish. *Journal of Memory and Language*, *66*, 17-37.

Bowerman, M. (1996a). Learning how to structure space for language: A crosslinguistic perspective. In P. Bloom, M. A. Peterson, L. Nadel, and M. F. Garrett (Eds.), *Language and space* (pp. 385-436). Cambridge, MA: MIT Press.

Bowerman, M., (1996b). The origins of children's spatial semantic categories: Cognitive versus linguistic determinants. In J. J. Gumperz & S. Levinson (Eds.), *Rethinking linguistic relativity* (pp. 145-176). Cambridge: Cambridge University Press.

Brown, R. (1958). How shall a thing be called? *Psychological Review*, *65*, 14-21.

Büchel, C., Josephs, O., Rees, G., Turner, R., Frith, C., & Friston, K. (1998). The functional anatomy of attention to visual motion: A functional MRI study. *Brain*, *121*, 1281–1294.

Carey, S. (2009). The origin of concepts. Oxford: Oxford University Press.

Casasola, M. & Cohen, L. (2002). Infant categorization of containment, support and tight-fit spatial relationships. *Developmental Science*. *5*, 247-264.

Choi, S. & Bowerman, M. (1991). Learning to express motion events in English and Korean: The influence of language-specific lexicalization patterns. *Cognition*, *42*, 83-121.

Csibra, G., Bíró, S., Koós, O., & Gergely, G. (2003). One-year-old infants use teleological representations of actions productively. *Cognitive Science*, *27*, 111–133.

Clark, E.V. (1983). Meanings and concepts. In J. H. Flavell and E. M. Markman (Eds.), *Handbook of child psychology, vol. 3: Cognitive development* (General editor: Paul H. Mussen) (pp. 787 – 840). New York: John Wiley and Sons.

Clark, H. H. (1973). Space, time, semantics, and the child. In T. Moore (Ed.), *Cognitive development and the acquisition of language* (pp. 27-63). New York: Academic Press.

Corter, J. E. (1982). ADDTREE/P: A PASCAL program for fitting additive trees based on Sattath & Tversky's ADDTREE program. *Behavior Research Methods and Instrumentation*, *14*, 353-354.

Coventry, K., Valdés, B., & Guijarro-Fuentes, P. (2010). Thinking for speaking and immediate memory for spatial relations. In Han, Z. & Cadierno, T. (Eds.), *Linguistic Relativity in SLA: Thinking for Speaking.* Bristol: Multilingual Matters.

de Boinod, A. J. (2006). *The meaning of tingo: and other extraordinary words from around the world.* London: Penguin Books Ltd.

Davidoff, J., Goldstein, J., Tharp, I., Wakui, E., & Fagot, J. (2012). Perceptual and categorical judgements of colour similarity. *Journal of Cognitive Psychology*, *24*, 871-892.

Dougherty, J. W.D. (1978). Salience and relativity in classification. *American Ethnologist*, *5*, 66-80

Dunn, M., Greenhill, S. J., Levinson, S. C., & Gray, R. D. (2011). Evolved structure of language shows lineage-specific trends in word-order universals. *Nature*, *473*, 79-82.

Ekman, P. (1992). An argument for basic emotions. *Cognition and Emotion*, *6*, 169–200.

Evans, N., & Levinson, S. C. (2009). The myth of language universals: Language diversity and its importance for cognitive science. *Behavioral and Brain Sciences*, *32*, 429-492.

Feist, M. I. (2008). Space between languages. *Cognitive Science*, *32*, 1177-1199.

Fodor, J. A. (1975). *The language of thought*. Cambridge, Massachusetts: Harvard University Press.

Fodor, J. A. (1998). *Concepts: Where cognitive science went wrong*. Oxford: Oxford University Press.

Gathercole, V. C. M. & Moawad, R. A. (2010). Semantic interaction in early and late bilinguals: All words are not created equally. *Bilingualism: Language and Cognition*, *13*, 385–408.

Gelman, S.A. (2006). Early conceptual development. In McCartney, & Phillips, D. (Eds). *Blackwell handbook of early childhood development. Blackwell handbooks of developmental psychology*. (pp. 149-166). Malden, MA, US: Blackwell Publishing.

Gelman, S. A. & Davidson, N. S. (1990). Inductions from novel categories: The role of language and conceptual structure. *Cognitive Development*, *5*, 151-176.

Gelman, S. A., & Markman, E. M. (1986). Categories and induction in young children. *Cognition*, *23*, 183-209.

Gennari, S., Sloman, S.A., Malt, B. C., and Fitch, W.T. (2002). Motion events in language and cognition. *Cognition*, *83*, 49-79.

Gentner, D. (2005). The development of relational category knowledge. In Gershkoff-Stowe, L. & Rakison, D. H. (Eds). *Building object categories in developmental time. Carnegie Mellon Symposia on cognition*. (pp. 245-275). Mahwah, NJ: Lawrence Erlbaum.

Gentner, D. & Bowerman, M. (2009). Why some spatial semantic categories are harder to learn than others: The typological prevalence hypothesis. In Guo, J., Lieven, E., Budwig, N. Ervin-Tripp, S. Nakamura, K., & Õzçaliskan, S. (Eds). *Crosslinguistic approaches to the psychology of language: Research in the tradition of Dan Isaac Slobin*. (pp. 465-480). New York, NY: Psychology Press.

Gentner, D. & Goldin-Meadow, S. (2003). Language in mind: Advances in the study of language and thought. Cambridge: MIT Press.

Göksun, T., Hirsh-Pasek, K., & Golinkoff, R.M. (2010). Trading spaces: Carving up events for learning language. *Perspectives on Psychological Science*, *5*, 33-42.

Goldstein, E. B. (2005). *Cognitive psychology: Connecting mind, research, and everyday experience*. Belmont, CA: Thomson Wadsworth.

Gumperz, J.J. and Levinson, S. C. (Eds.) (1996). *Rethinking linguistic relativity*. Cambridge: Cambridge University Press.

Hampton, J. (1997). Conceptual combination: Conjunction and negation of natural concepts. *Memory & Cognition, 25,* 888-909.

Hampton, J. (2012). Thinking intuitively: The rich (and at times illogical) world of concepts. *Current Directions in Psychological Science, 21*, 398-402.

Harnad, S. (2005). To cognize is to categorize: Cognition is categorization. In H. Cohen & C. Lefebvre (Eds.), *Handbook of Categorization in Cognitive Science* (pp. 20-45). Amsterdam: Elsevier.

Heit, E. (2000). Properties of inductive reasoning. *Psychonomic Bulletin and Review, 7,* 569-592.

Henning, H. (1916). Die qualitatenreihe des geschmacks (The quality series of taste). *Zeitschrift Psychologie*, *74*, 203–19.

Hills, T.T., Maouene, M., Maouene, J. Sheya, A., & Smith, L. (2009). Categorical structure among shared features in networks of early-learned nouns. *Cognition*, *112*, 381-396.

Huettig, F., Chen, J., Bowerman, M., & Majid, A. (2010). Do language-specific categories shape conceptual processing? Mandarin classifier distinctions influence eye gaze behavior, but only during linguistic processing. *Journal of Cognition and Culture*, *10*, 39–58.

Hunn, E. (1977). *Tzeltal folk zoology: The classification of discontinuities in nature*. New York: Academic Press.

Huth, A. G., Nishimoto, S., Vu, A. T., & Gallant, J. L. (2012). A continuous semantic space describes the representation of thousands of object and action categories across the human brain. *Neuron, 76,* 1210-1224.

Imai, M. & Saalbach, H. (2010). Categories in mind and categories in language: Do classifier categories influence conceptual structures? In B.C. Malt and P. Wolff (Eds.), *Words and the mind: How words capture human experience* (pp. 138-164). New York: Oxford University Press

Jackendoff, R. S. (1990). *Semantic structures*. Cambridge, MA: The MIT Press.

Jones, D. (2010). Human kinship, from conceptual structure to grammar. *Behavioral and Brain Sciences*, *33*, 367-404.

Just, M. A., Cherkassky, V.L., Aryal, S., & Mitchell, T. M. (2010). A neurosemantic theory of concrete noun representation based on the underlying brain codes. *PLoS ONE*, *5*(1): e8622. doi:10.1371/journal.pone.0008622

Kable, J. W., Kan, I. P., Wilson, A. Thompson-Schill, S. L. & Chatterjee, A. (2005). Conceptual representations of action in lateral temporal cortex. *Journal of Cognitive Neuroscience, 17,* 1855-1870.

Kalénine, S., Mirman, D., Middleton, E. L., Buxbaum, L. J. (2012).Temporal dynamics of activation of thematic and functional knowledge during conceptual processing of manipulable artifacts. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *38*, 1274-1295.

Kay, P., Berlin, B., Maffi, L., & Merrifield, W. (1997). Color naming across languages. In C. L. Hardin & L. Maffi (Eds), *Color categories in language and thought*. Cambridge: Cambridge University Press.

Keil, F. C. (1989). *Concepts, kinds, and cognitive development.* Cambridge, MA: MIT Press.

Kelemen, D. & Carey, S. (2007). The essence of artifacts: Developing the design stance. In In E. Margolis and S. Laurence (Eds.). *Creations of the mind: Theories of artifacts and their representation* (pp. 212-230). New York: Oxford University Press.

Khetarpal, N., Majid, A., & Regier, T. (2009). Spatial terms reflect near-optimal spatial categories. In N. Taatgen et al. (Eds.), *Proceedings of the 31st Annual Conference of the Cognitive Science Society* (pp. 2396-2402).

Kinzler, K. D., & Spelke, E. S. (2007). Core systems in human cognition. *Progress in Brain Research, 164*, 257-264.

Kronenfeld, D. B., Armstrong, J.D., and Wilmoth, S. (1985). Exploring the internal structure of linguistic categories: An extensionist semantic view. In J.W.D. Dougherty (Ed.). *Directions in Cognitive Anthropology* (pp. 91-113). Urbana: University of Illinois Press.

Kruschke, J. K. (2005). Category learning. In K. Lamberts and R. L. Goldstone (Eds.), *The Handbook of Cognition* (pp. 183-201). London: Sage.

Lakoff, G. (1987). *Women, fire, and dangerous things*. Chicago: University of Chicago Press.

Landau, B., & Jackendoff, R. (1993). "What" and "where" in spatial language and spatial cognition. *Behavioral and Brain Sciences*, *l6*, 217-238.

Lucy, J. (2010). Language structure, lexical meaning, and cognition: Whorf and Vygotsky revisited. In B.C. Malt and P. Wolff (Eds.), *Words and the mind: How words capture human experience* (pp. 266-286). New York: Oxford University Press.

Mahon, B. Z & Caramazza, A. (2007). The organization and representation of conceptual knowledge in the brain: Living kinds and artifacts. In E. Margolis and S. Laurence (Eds.). *Creations of the mind: Theories of artifacts and their representation* (pp. 157-187). New York: Oxford University Press.

Majid, A., Boster, J. S., & Bowerman, M. (2008). The cross-linguistic categorization of everyday events: A study of cutting and breaking. *Cognition*, *109*, 235-250.

Majid, A., Enfield, N. J., & van Staden, M. (2006). Parts of the body: Cross-linguistic categorisation. Special issue of *Language Sciences*, *28*(2-3).

Majid, A., & Huettig, F. (2008). A crosslinguistic perspective on semantic cognition. *Behavioral and Brain Sciences, 31*, 720-721.

Majid, A., & Levinson, S. C. (2011). The senses in language and culture. *The Senses & Society, 6*, 5-18.

Malt, B.C. (1991). Word meaning and word use. In P. Schwanenflugel (Ed.), *The psychology of word meaning*, pp. 37-70. Hillsdale, NJ: Lawrence Erlbaum Associates.

Malt, B.C. (1995). Category coherence in cross-cultural perspective. *Cognitive Psychology*, *29*, 85-148.

Malt, B.C., Gennari, S., and Imai, M. (2010). Lexicalization patterns and the world-to-words mapping. In B.C. Malt and P. Wolff (Eds.), *Words and the mind: How words capture human experience* (pp. 29-57). New York: Oxford University Press.

Malt, B.C., Gennari, S., Imai, M., Ameel, E., Tsuda, N., & Majid, A. (2008). Talking about walking: Biomechanics and the language of locomotion. *Psychological Science*, *19*, 232-240.

Malt, B.C., Gennari, S., Imai, M., Ameel, E., Saji, N., & Majid, A. (2013). Human locomotion in languages: Constraints on moving and meaning. Under review.

Malt, B. C. and Sloman, S. A. (2007). Artifact categorization: The good, the bad, and the ugly. In E. Margolis & S. Laurence (Ed.), *Creations of the mind: Theories of artifacts and their representation* (pp.85-123). Oxford University Press.

Malt, B. C., Sloman, S. A., & Gennari, S. (2003). Universality and language-specificity in object naming. *Journal of Memory and Language*, *49*, 20-42.

Malt, B. C., Sloman, S. A., Gennari, S., Shi, M., & Wang, Y. (1999). Knowing versus naming: similarity and the linguistic categorization of artifacts. *Journal of Memory and Language*, *40*, 230-262.

Malt, B. C. and Wolff, P. (Eds.) (2010). *Words and the mind: How words capture human experience*. New York: Oxford University Press.

Mantel, N. (1967). The detection of disease clustering and a generalized regression approach. *Cancer Research*, *27***,** 209–220.

McClelland, J. L., Rumelhart, D. E., & Hinton, G. E. (1986). The appeal of parallel distributed processing. In D. E. Rumelhart, J. L. McClelland, & the PDP Research Group. *Parallel distributed processing: Explorations in the microstructure of cognition, Volume I,* pp. 3-44. Cambridge, MA: MIT Press.

Medin, D.L. & Rips, L.J. (2005). Concepts and categories: Memory, meaning, and metaphysics. In K. Holyoak & R. Morrison (Eds.), *Cambridge handbook of thinking and reasoning* (pp. 37-72). Cambridge : Cambridge University Press.

Munnich, E., Landau, B., & Dosher, B. A. (2001). Spatial language and spatial representation: A cross-linguistic comparison. *Cognition*, *81*, 171-207.

Murphy, G. L. (1988). Comprehending complex concepts. *Cognitive Science*, *12*, 529-562.

Murphy, G. L. (2002). *The big book of concepts*. Cambridge, MA: The MIT Press.

Nairne, J. S., & Pandeirada, J. N. S. (2008). Adaptive memory: Is survival processing special? *Journal of Memory and Language,* 59, 377-385.

Osherson, D. N., Smith, E. E., Wilkie, O., Lopez, A., & Shafir, E. (1990). Category-based induction. *Psychological Review, 97,* 185-200.

Papafragou, A., Hulbert, J., & Trueswell, J. (2008). Does language guide event perception? Evidence from eye movements. *Cognition*, *108*, 155-184.

Papafragou, A., Massey, C., & Gleitman, L. (2006). When English proposes what Greek presupposes: The cross-linguistic encoding of motion events. *Cognition*, *98*, B75-B87.

Parish-Morris, J., Pruden, S., Ma, W., Hirsh-Pasek, K., & Golinkoff, R. (2010). A World of relations: Relational words. In Malt, B.C. & Wolff, P. (Eds.), *Words and the mind: How words capture human experience* (pp. 219-242). NewYork: Oxford University Press.

Phillips, W. & Santos, L. R. (2007). Evidence for kind representations in the absence of language: Experiments with rhesus monkeys (Macaca mulatta). *Cognition*, *102*, 455–463.

Pinker, S. (2007). *The stuff of thought: Language as a window into human nature*. New York: Viking.

Prinz, J. J. (2002). *Furnishing the mind: Concepts and their perceptual basis*. Cambridge, MA:MIT Press.

Quine, W.V. (1970). Natural kinds. In N. Rescher (Ed.), *Essays in honor of Carl G. Hempel.* Dordrecht: D. Reidel.

Raymond, J. (2000). Attentional modulation of visual motion perception. *Trends in Cognitive Sciences*, *4*, 42-50.

Regier, T., Kay, P., & Khetarpal, N. (2007). Color naming reflects optimal partitions of color space. *Proceedings of the National Academy of Sciences, 104,* 1436-1441.

Roberson, D., Davies, I. R. L., Corbett, G. G., & Vandervyver, M. (2005). Free-Sorting of Colors Across Cultures: Are there Universal Grounds for Grouping? *Journal of Cognition and Culture, 5*, 349-386.

Roberson, D., & Davidoff, J. (2000). The categorical perception of colors and facial expressions: The effect of verbal interference. *Memory & Cognition*, *28*, 977–986.

Rogers, T. T. & McClelland, J. L. (2004). *Semantic cognition: A parallel distributed processing approach*. Cambridge, MA: MIT Press.

Rosch, E., & Mervis, C. B. (1975). Family resemblances: Studies in internal structure of categories. *Cognitive Psychology*, *7*, 573–605.

Rosch, E., Mervis, C.B., Gray, W.D., Johnson, D., & Boyes-Braem, P. (1976). Basic objects in natural categories. *Cognitive Psychology*, *8*, 382-439.

Rothkopf, E. (1957). A measure of stimulus similarity and errors in some paired-associate learning tasks, *Journal of Experimental Psychology 53*, 94–101.

SAS Institute Inc. (1999). *SAS STAT ® Users's Guide 8*. Cary, NC: SAS Institute Inc.

Saalbach, H. &; Imai, M. (2007). The scope of linguistic influence: Does a classifier system alter object concepts? *Journal of Experimental Psychology: General*, *136*, 485-501.

Saalbach, H. & Imai, M. (2012). The relation between linguistic categories and cognition: The case of numeral classifiers. *Language and Cognitive Processes*, *27*, 381-428.

Saji, N., Imai, M., Saalbach, H., Zhang, Y., Shu, H., & Okada, H. (2011). Word learning does not end at fast mapping: Evolution of verb meanings through reorganization of an entire semantic domain. *Cognition*, *118*, 45-61.

Sattath, S. & Tversky, A. (1977). Additive similarity trees. *Psychometrika*, *42*, 319-345.

Sauter, D. A., LeGuen, O., & Haun, D. B. M. (2011). Categorical perception of emotional facial expressions does not require lexical categories. *Emotion*, *11*, 1479–1483.

Schank, R. C. & Abelson, R. P. (1977). *Scripts, plans, goals, and understanding: An inquiry into human knowledge structures.* Hillsdale, NJ: Erlbaum.

Seligman, M.E.P. (1971). Phobias and preparedness. *Behavior Therapy*, *2*, 307-320.

Shepard, R. N. & Chang, J.-J. (1963). Stimulus generalization in the learning of classifications. *Journal of Experimental Psychology*, *65*, 94-102.

Slobin, D. (1996a). From "thought and language" to "thinking for speaking". In J. J. Gumperz and S. C. Levinson (Eds.), *Rethinking linguistic relativity* (pp. 70-96). Cambridge: Cambridge University Press.

Slobin, D. (1996b). Two ways of travel: Verbs of motion in English and Spanish. In M. Shibatani & S. Thompson (Eds.). *Grammatical constructions: Their form and meaning*. Oxford: Clarendon Press.

Slobin, D. (2010). Linguistic relativity and determinism: Whence and whither? Plenary talk presented at the German Linguistics Society, Berlin, Germany.

Sloman, S.A. & Malt, B.C. (2003). Artifacts are not ascribed essences, nor are they treated as belonging to kinds. *Language and Cognitive Processes [Special Issue: Conceptual Representation]*, *18*, 563-582.

Smith, E. E., & Medin, D. L. (1981). *Categories and concepts*. Cambridge, MA: Harvard University Press.

Smith, L.B. & Samuelson, L. (1997). Perceiving and remembering: Category stability, variability, and development. In Lambert, K. & Shanks, D. (Eds.) *Knowledge. concepts. and categories* (pp. 161-196). East Sussex, UK: Psychology Press.

Solomon, K. O., Medin, D. L., & Lynch, E. B. (1999). Concepts do more than categorize. *Trends in Cognitive Science*, *3*, 99-105.

Smolensky, P. (1988). On the proper treatment of connectionism. *Behavioral and Brain Sciences*, *11*, 1-74.

Spelke, E. S. (1994). Initial knowledge: Six suggestions. *Cognition, 50*, 431-445.

Talmy, L. (1985). Lexicalization patterns: Semantic structure in lexical forms. In T. Shopen (Ed.). *Language typology and syntactic description, vol. 3: Grammatical categories and lexicon* (pp. 56-149). Cambridge: Cambridge University Press.

Ullman, S. (1998). Three-dimensional object recognition based on the combination of views. *Cognition, 67*, 21–44.

Ullman, S., Vidal-Naquit, M. & Sali, E. (2002). Visual features of intermediate complexity and their use in classification. *Nature Neuroscience*, *5*, 682-687.

Webster, M. A., & Kay, P. (2012). Color categories and color appearance. *Cognition*, *122,* 375-392.

Willems, R. M., de Boer, M., de Ruiter, J. P., Noordzij, M. L., Hagoort, P. & Toni, I. (2010). A dissociation between linguistic and communicative abilities in the human brain. *Psychological Science*, *21*, 8-14.

Willingham, D. T. (2007). *Cognition: The thinking animal (3rd Edition)*. Upper Saddle River, NJ: Pearson.

Whorf, B. L. (1956). *Language, thought, and reality: Selected writings of Benjamin Lee Whorf*. J. B. Carroll (Ed). Cambridge, MA: MIT Press.

Wierzbicka, A. (1999). *Emotions across languages and cultures*. Cambridge: Cambridge University Press.

Wierzbicka, A. (2009). Language and metalanguage: Key issues in emotion research. *Emotion Review*, *1*, 3-14.

Wisniewski, E. (1996). Construal and similarity in conceptual combination. *Journal of Memory and Language*, *35*, 434-453.

Wolff, P., Klettke, B., Ventura, T., & Song, G. (2005). Expressing causation in English and other languages. In W. Ahn, R. L. Goldstone, B. C., Love, A. B. Markman, & P. Wolff (Eds.), *Categorization inside and outside the laboratory: Essays in honor of Douglas L. Medin* (pp. 29–48). Washington, DC: American Psychological Association.

Wolff, P. & Malt, B. C. (2010). The language-thought interface: An introduction. In B.C. Malt and P. Wolff (Eds.), *Words and the mind: How words capture human experience* (pp. 3-15). New York: Oxford University Press.

Wolff, P., Medin, D., & Pankratz, C. (1999). Evolution and devolution of folkbiological knowledge. *Cognition*, *73*, 177-204.

Xu, F. (2005). Categories, kinds, and object individuation in infancy. In Gershkoff-Stowe, L. & Rakison, D. H. (Eds). *Building object categories in developmental time. Carnegie Mellon Symposia on cognition*. (pp. 63-89). Mahwah, NJ: Lawrence Erlbaum.

Footnotes

1. We use “names” throughout this discussion to refer to the linguistic labels given to sets of objects, actions, relations, and properties (not only to those given to individual people, places, pets, etc., i.e., proper names).

2. There is considerable variation between Netherlands and Belgian Dutch, and also in varieties of Spanish and English spoken around the globe. Readers may have naming preferences that differ from those reported here due to dialect differences. Most notably, *lopen* has a substantially different use in Holland than in Belgium, being used primarily for fast locomotion in Belgium and slow locomotion in Holland.

3. A related approach to the search for conceptual primitives occurs in recent developmental work on core cognition (e.g., Carey, 2009; Cisbra, Bíró, Koós, & Gergely, 2003; Kinzler & Spelke, 2007; Spelke, 1994), in which researchers study representations (e.g., of objecthood, causality, agency, and number) that may provide the foundations of more complex conceptual understanding. This work focuses more specifically on representations hypothesized to be innate and aims to understand their nature in detail.

Also related is recent work in computational and human neuroscience that seeks shared features underlying semantic representations (e.g., Just, Cherkassky, Aryal, & Mitchell, 2010) and argues for a continuous semantic space (Huth, Nishimoto, Vu, & Gallant, 2012).

4. Some early precursors to modern connectionist models were more “localist” in nature, having internal nodes labeled with words of a language (e.g., McClelland, Rumelhart, & Hinton, 1986), but the essential nature of current models is that knowledge is reflected in a distributed pattern of activation across nodes.

Table 1

Inventory of Locomotion Names

Language			
English	Dutch	Spanish	Japanese
creep	hinkelen	caminar	aruku
gallop	huppelen	correr	hashiru
hop	joggen	marchar	**sukippu-suru**
jog	lopen	saltar	**ashibumi-suru**
jump	marcheren	trotar	**kenken-suru**
leap	rennen		**koushin-suru**
march	slenteren		**janpu-suru**
run	sluipen		
skip	springen		
stomp	stappen		
walk	wandelen		
shuffle			
tiptoe			
power walk			

Note. **Boldface** indicates terms that have more than one morpheme.

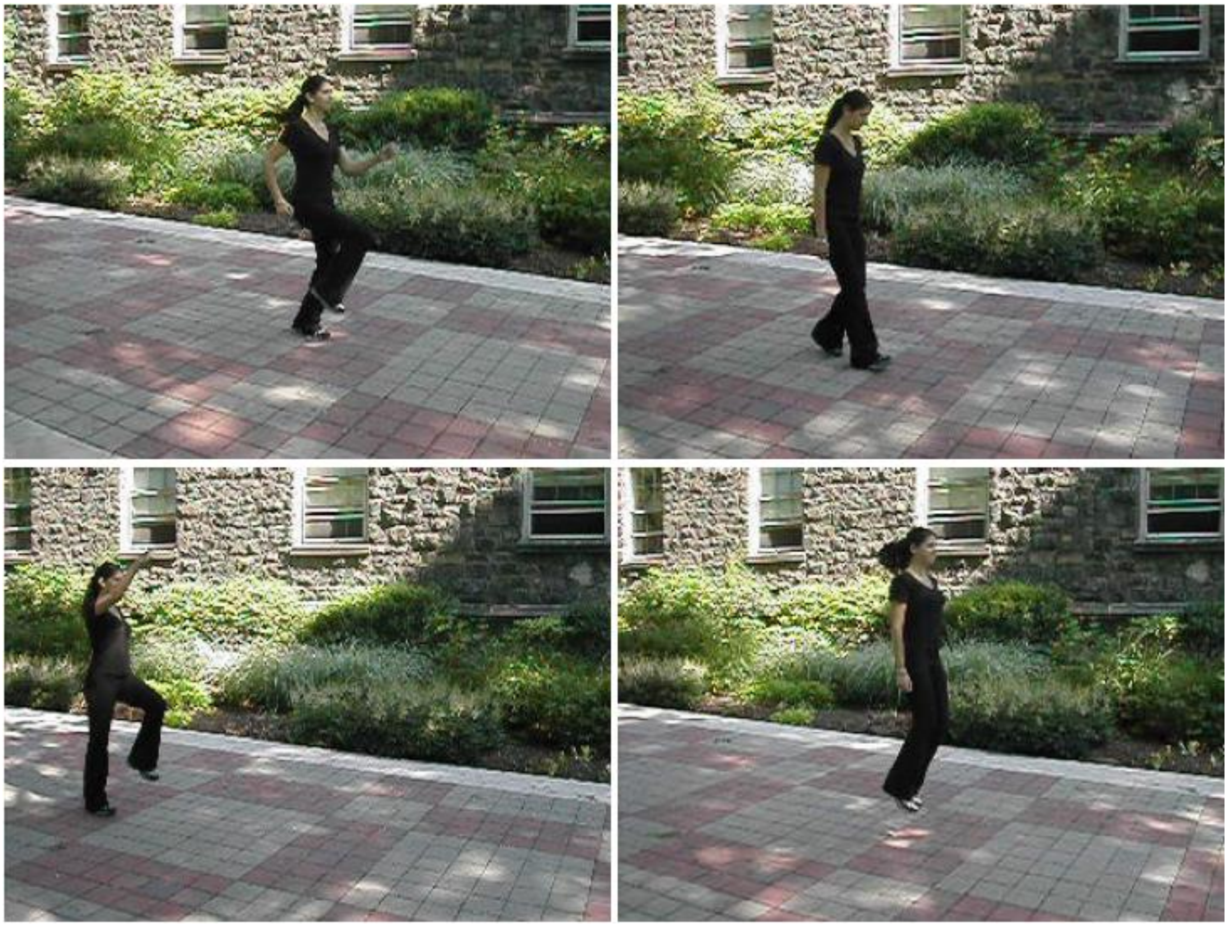

Fig. 1. Sample frames from clips.

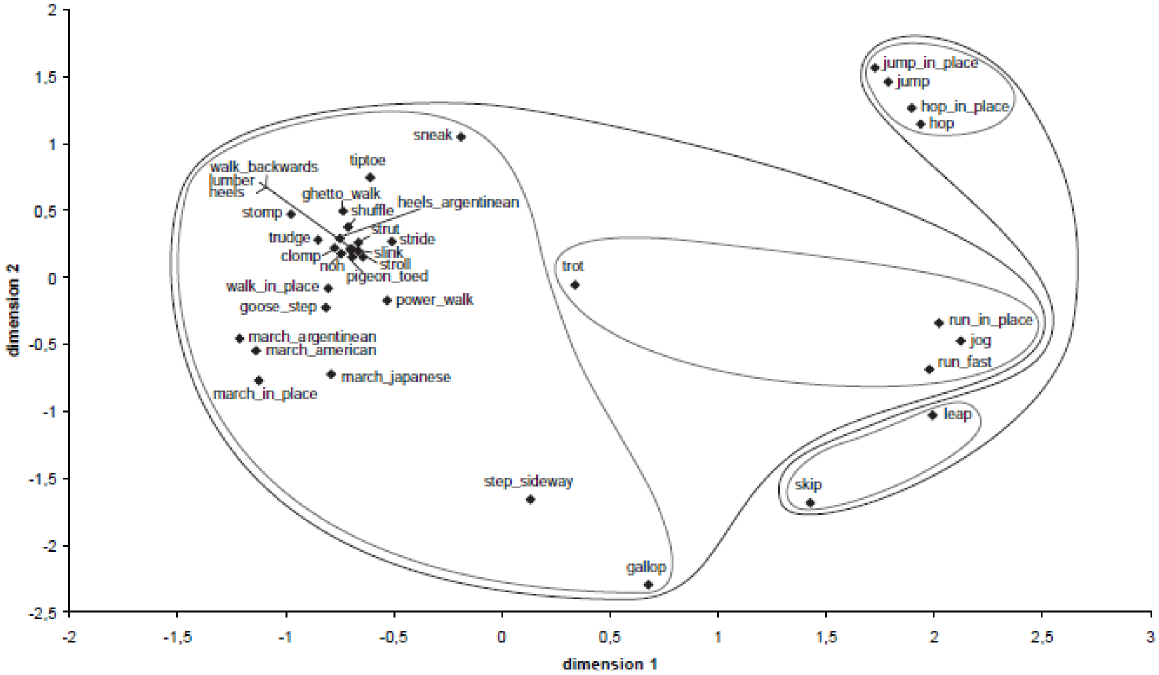

Fig. 2. MDS solution based on American English naming data. Clip names refer to names bestowed by the experimenters, not names produced by participants.

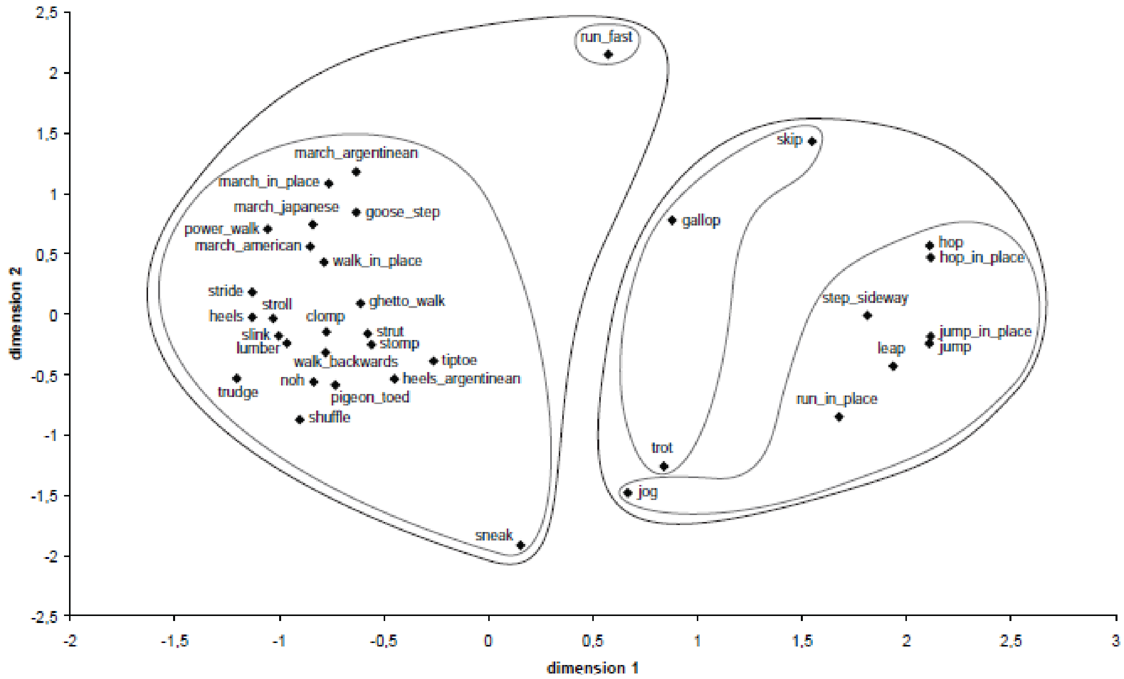

Fig. 3. MDS solution based on Belgian Dutch naming data. Clip names refer to names bestowed by the experimenters, not names produced by participants.

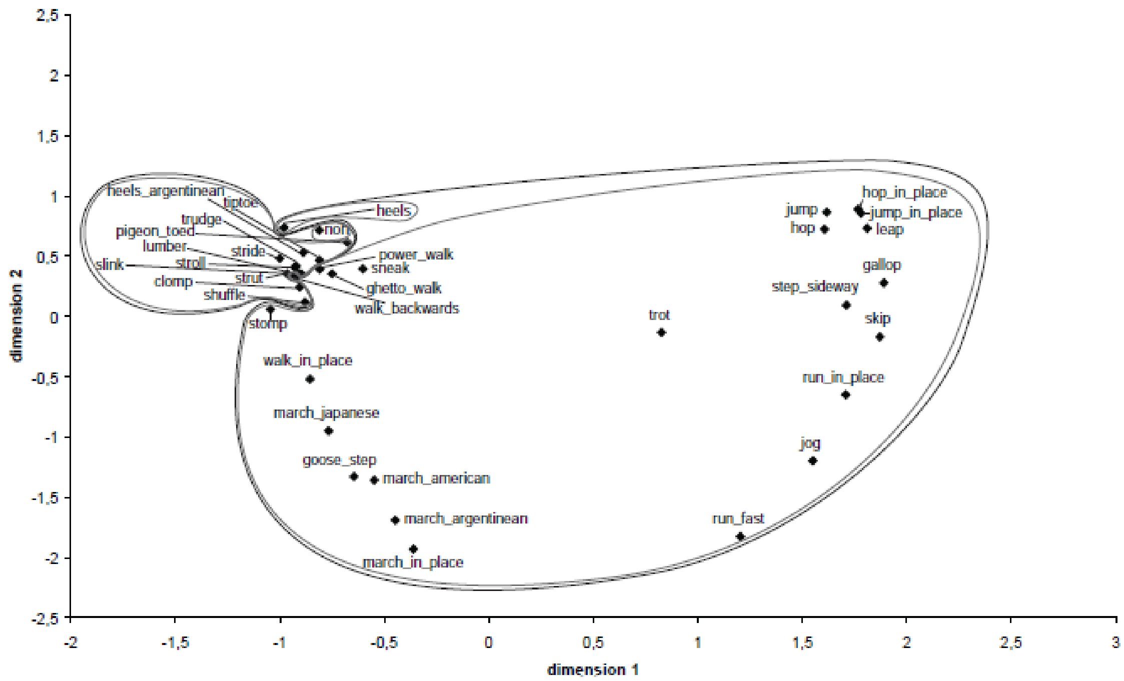

Fig. 4. MDS solution based on Argentinean Spanish naming data. Clip names refer to names bestowed by the experimenters, not names produced by participants.

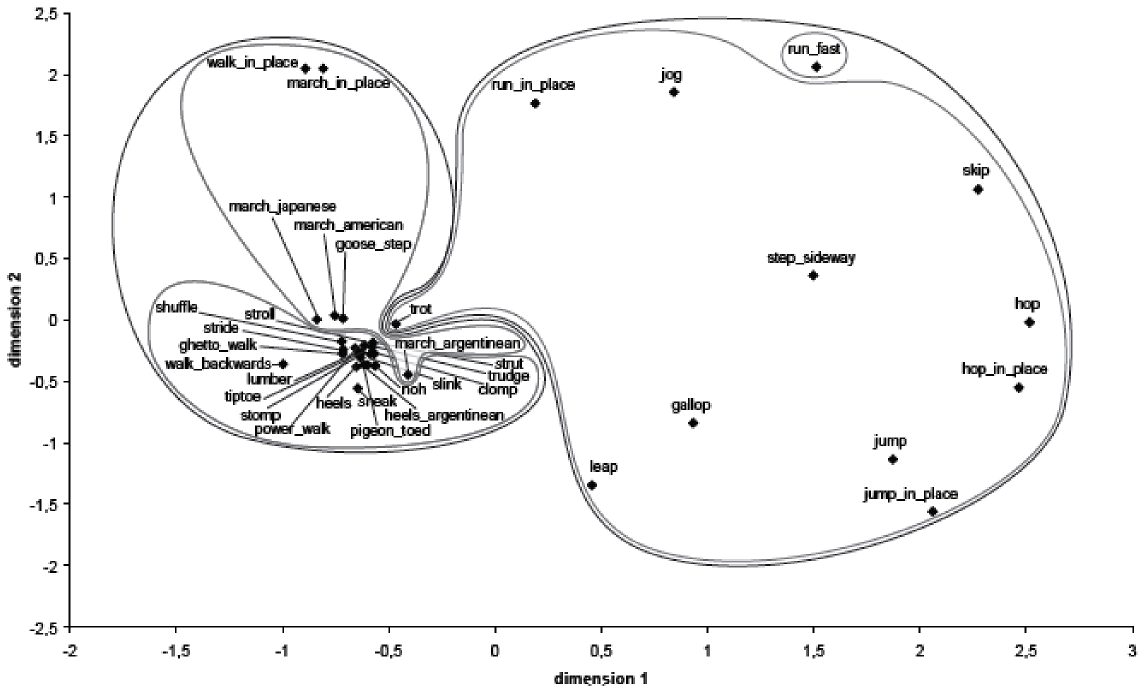

Fig. 5. MDS solution based on Japanese naming data. Clip names refer to names bestowed by the experimenters, not names produced by participants.

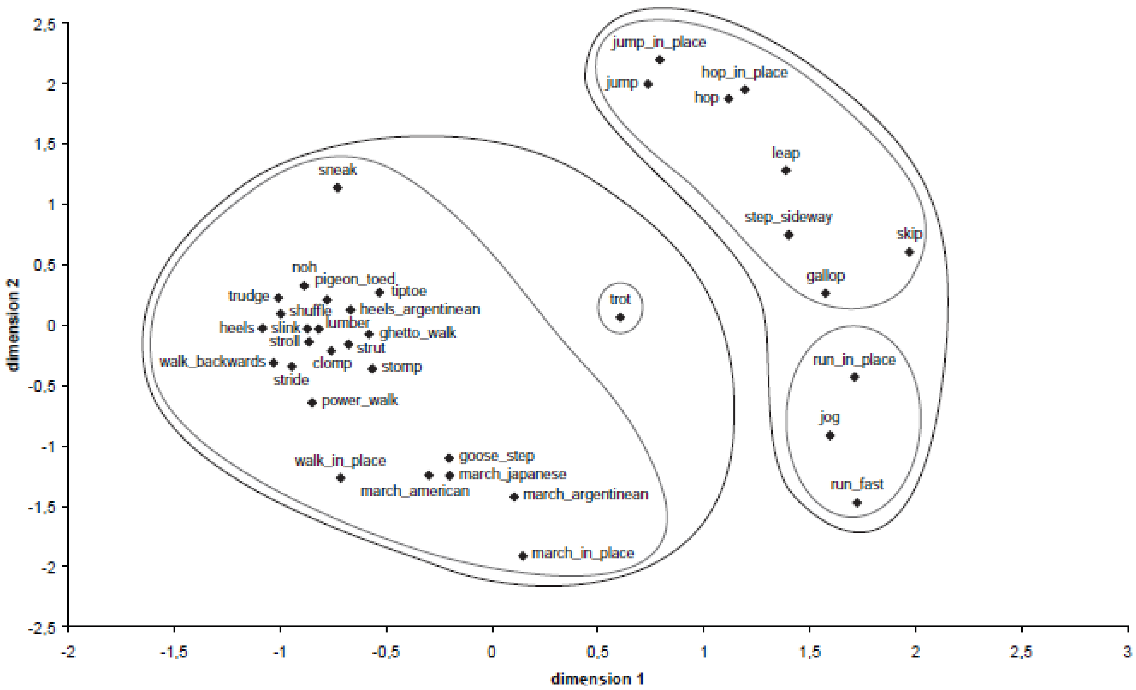

Fig. 6. MDS solution based on the four languages' combined naming data. Clip names refer to names bestowed by the experimenters, not names produced by participants.