The cross-linguistic categorization of everyday events:

A study of "cutting and breaking"

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Abstract

The systematic cross-linguistic investigation of semantic categories has a long history, spanning many disciplines and covering many domains. Nevertheless, the question of whether semantic categories are universal or relative remains highly controversial. This study investigated how speakers of different languages categorize everyday events involving material destruction, such as “cutting” and “breaking”. Speakers of 28 typologically, genetically, and geographically diverse languages described events shown in a set of videoclips, and the verbs that were used to describe these clips were subject to multivariate statistical analyses. The results show that there is considerable agreement in the dimensions along which events were distinguished across languages, but variation in the number of categories and the placement of their boundaries. This suggests that there are strong constraints in human event categorization, and that variation is played out within a restricted semantic space.

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Introduction

The systematic cross-linguistic study of how semantic categories are expressed in signs (words, morphemes, constructions etc.) has a long history spanning many disciplines, including anthropology, linguistics and psychology (for a recent overviews see Boster, 2005; Evans, in press). Classic domains of enquiry include color (Berlin & Kay, 1969), emotion (Ekman, 1971; Ekman & Friessen, 1975), ethnobiology (Berlin, Breedlove, & Raven, 1973; Berlin, 1992), the human body (Anderson, 1978; Brown, 1976) and kinship (Goodenough, 1956; Lounsbury, 1956). Despite the long history there is still relatively little consensus on whether naming across languages is constrained by general principles, or free to vary arbitrarily. Universals of nomenclature once thought to be established are being reexamined in the light of new empirical data – cf. Roberson, Davies, and Davidoff (2000) versus Kay and Regier (2003) on color; Russell (1994) versus Ekman (1994) on emotion; Majid, Enfield, and van Staden (2006) versus Wierzbicka (2007) on the body – and the outcome still to be determined.

A major advance in the current debate has been the use of the use of standardized data collection across a wide variety of languages and cultures and the use of statistical techniques that allow quantifiable measures of agreement and disagreement across languages (Kay & Regier, 2003; Regier, Kay & Khetarpal, 2007; see also Levinson & Meira, 2003). We follow this model in the current paper to investigate semantic categorization of events, specifically events of "cutting and breaking". The aim of the study is to investigate how people categorize such events with verbs: we assume to the extent that speakers of different languages agree with one another in how they label events there is a common conceptualization of events. Obviously, if languages diverge in labeling of events then there is little we can conclude about underlying conceptualization since non-linguistic conceptualization could follow linguistic categorization, consistent with a Whorfian perspective, or could be impervious to and distinct from linguistic categories, consistent with a modularist perspective. But if languages *do* share structure in linguistic categorization, we argue this is prima facie evidence for the structure non-linguistic conceptualization must have too.

In the current paper, we investigate the linguistic categorization of events – specifically "cutting and breaking" events – in a typologically, genetically and geographically diverse set of languages. We show that despite variation in the number of categories these languages have, or the exact boundaries of these categories, they nonetheless all share a semantic space which can be characterized by a small set of dimensions. We argue that these dimensions reveal a common conceptualization of "cutting and breaking" events that speakers of all languages possess.

Event categories in language

While there is a long history of research on a number of semantic domains, there is surprisingly little in the domain of events. This stems in part from the practical difficulties (until recently) of showing dynamic stimuli in a standardized fashion to people in different communities. In addition there are theoretically grounded reasons for why researchers have not sought to find universals in this domain, although these remain relatively implicit. One such factor stems from a distinction made in describing languages, that is the division between open-class and close-class items. Open-class items are large in number and new additions can readily be incorporated. They refer to objects, events and properties, and can be sub-classified into nouns, verbs and adjectives. Closed-class items, on the other hand, are small in number and new items are not easily incorporated. These items relate elements of the open-class items to each other, as well as to the discourse perspective of the speaker. Closed-class items can be free words such as conjunctions and prepositions, bound morphemes such as prefixes, suffixes and infixes or dependent morphemes such as clitics.

There is a wide-spread belief that open-class categories are less likely to reflect regularities than are closed-class categories, or to put it another way that the lexicon is free to vary arbitrarily – after all we can always invent a new word to package a new idea but the concepts in grammatical morphemes seem to be from a much more restricted stock (e.g., Bickerton, 1981; Kemmer, 2003; Pinker, 1984; Slobin, 1985; Talmy, 1985; 1988). The assumption of free variation in the lexicon discourages systematic cross-linguistic study of open-class items in general, and verbs in particular, since from this perspective verb meaning is unlikely to display robust regularities.

That event categories expressed in languages vary massively has been fostered by the work of Talmy (1985) on motion events. Talmy claimed that languages vary in which meaning elements are expressed in verbs. Along with the basic fact of motion, English typically packages manner information into the verb (e.g., *run*, *jog*, *walk*, *stroll*), while Spanish omits manner but includes path information (e.g., *entrar*, ‘go-in’; *salir*, ‘go-out’), Atsugewi (a Hokan language of northern California) includes information about the figure, and Japanese information about the ground (Muehleisen & Imai, 1997). Thus it appears that languages vary substantially in their event categories, leading Gentner (1982) to suggest that “the referents of verbs are perceptually less constrained, and therefore more variable across languages than the referents of simple nominals” (p. 324). Gentner proposed that perceptual/conceptual elements packaged in the verb have few internal relations to one another, and do not cohere together.

This echoes an earlier proposal by Huttenlocher and Lui (1979) on the contrast between object and event categories. They suggested that although object categories comprise correlated features, event categories are organized in a matrix-like structure of unordered features. For objects the presence of one feature, such as “has-beak”, is highly predictive of other features, such as “has-wings”, “has-2-legs”, “can-fly” etc.; but for events, the presence of a particular semantic element, such as type of instrument is not informative about whether other features will also be present, such as object acted upon or manner employed. Thus the hypothesis is that event categories as reflected in verbs show much less regularity than object categories as reflected in nouns.

In comparison to grammatical morphemes, then, open-class items are thought to display less constraint and regularity in which meanings are expressed, and within open-class items verbs are thought to display less regularity again in how semantic elements are packaged. This set of assumptions has meant that little effort has gone into discovering whether across languages verb categories share a semantic space.

Event categories in cognition

The lack of research on verb semantics and event conceptualization is not limited to cross-linguistic investigations. Relatively little is known about the mental representation of events in mainstream psychology either, particularly in contrast to the vast literature on object categorization (see Zacks & Tversky, 2001 for an overview of the event representation literature). One line of research, with roots in social psychology, has investigated how people segment events (Newtson & Engquist, 1976; Newtson, Engquist, & Bois, 1977). Before categorization can occur, there must first be a process which identifies “chunks” in the continuous, dynamic input. Infants 10-11-months-old are able to parse on-going activity into units (Baldwin, Baird, Saylor & Clark, 2001). Neuroimaging evidence suggests that people segment ongoing activity into discrete events even when just passively viewing (Zacks, Braver, Sheridan, Donaldson, Snyder, Buckner, & Raichle, 2001). Boundaries between events often have key perceptual correlates like points of maximal change in the display (e.g., Newtson et al., 1977), consistent with a bottom-up view of event segmentation. But judgments about boundaries are also modulated by top-down inferences about actors' intentions (Zacks, 2004; but see Avrahami & Kareev, 1994 for an alternative view).

Another important line of work on event representation, originating in cognitive psychology and artificial intelligence, has examined the organization of event knowledge in scripts, frames, and schemas (Bartlett, 1932; Minsky, 1975; Rumelhart & Ortony, 1977; Schank & Abelson, 1977). Schank and Abelson (1977) proposed that humans have schemas that contain the sequence of actions associated with routine events. These schemas predict what will happen next, and have default values for steps left implicit. For example, "going to a restaurant", "going to the movies", "sports", or "housework", consist of sequences of finer-grained events such as "walking (into a restaurant)", "sitting down", "ordering", "eating", and "paying the bill" (Morris & Murphy, 1990; Rifkin, 1985).

Neither of these approaches to event representation has examined the issue of categorization of everyday events, i.e. which dynamic sequences count as being "of the same kind". Studies of event segmentation are a necessary precondition, perhaps, to examining event categorization but do not address the question directly. Script and frame research concentrates on complex higher-order events, which are known to be culturally mediated (Bartlett, 1932), and have thus by-passed the issue of what counts as an instance of the same activity. In short, there has been a paucity of research on event categorization.

Cutting and breaking events

In the present study, we focus on the linguistic categorization of a set of everyday events – "cutting and breaking" – involving "separation in the material integrity" of objects (Hale & Keyser's, 1987 term).[1] This domain was chosen because a priori it seems equally

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[1] The terms "cutting" and "breaking," with quotes, designate actions of the type that speakers of English typically label with verbs like *cut* and *break*; other languages may or may not have words with closely similar meanings. Throughout this paper, words in double quotation

plausible to predict that event categories in this domain are universal or variable. The manufacture and use of tools for purposes of cutting and breaking has been dated back to at least 2.5 million years ago in the East African Rift area, and modern humans (*Homo sapiens sapiens*) appear to be unique in making and using tools especially for “cutting”, such as pressure-flaked knives (de Beaune, 2004; Harris, 1983; Toth & Schick, 1993).[2] In favor of universality, cutting and breaking are practiced in every society, by practically every member of the society, and these actions do not require specialized knowledge, although there may be expert variants in a community, e.g. diamond cutting, quarrying. The fact that cutting and breaking have been central to human activity for such a long time suggests that there may be common ways of conceiving such events. Motivation for the universality of cutting and breaking categories comes from recent research in linguistics. It has been suggested that verbs of “cutting” have systematically different meanings from verbs of “breaking”, and that this leads to distinct syntactic behaviors for the two classes of verbs (Bohnemeyer, in press; Guerssel, Hale, Laughren, Levin, & White Eagle, 1985; Levin & Rappaport, 1995). This suggests that there is a uniform way of conceptualizing events in this domain, at least at a relatively abstract level.

On the other hand, although cutting and breaking has been part of the human repertoire since prehistory, the exact manifestation of these behaviors varies depending on the particular ecology and practices of a community. For instance, Americans and Europeans chop vegetables by holding them still and bringing a knife down on them from above,

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marks point to actions of a certain general type, and words in italics designate linguistic forms. Single quotes are used for meaning glosses of specific words.

[2] Great apes and monkeys may also engage in cutting with simple stone flakes (Schick, Toth, Garufi, Savage-Rumbaugh, Rumbaugh & Sevcik, 1999; Westergaard, 1995; Wright, 1972), consistent with the suggestion that these events are ancient and cognitively salient.

whereas Punjabi speakers in rural Pakistan and India often move the vegetables against a stationary curved knife. It is quite possible that such differences in practices lead to differences in the event categories recognized. Other linguistic work indicates that there can be substantial differences in the extension of “cutting and breaking” verbs. For example, English speakers use *break* for actions on a wide range of objects (e.g., a plate, a stick, a rope), while speakers of K’iche’ Maya must choose from among a set of “breaking” verbs on the basis of properties of the object; e.g., *-paxi:j* ‘break a rock, glass, or clay thing’ (e.g., a plate); *-q’upi:j* ‘break (other kinds of) hard thing’ (e.g., a stick); *-tóqopi’j* ‘break a long flexible thing’ (e.g., a rope) (Pye, 1996; Pye, Loeb, & Pao, 1995). Variation between languages within the “cutting and breaking” domain suggests there may not be clear cognitive categories of these events, while developmental data (Bowerman, 2005; Schaefer, 1979) suggests that the boundaries between cutting and breaking events, on the one hand, and events of separation, on the other hand, may also not be so obvious. For example, speakers of English do not use *cut* and *break* for actions like peeling a banana or pulling paper cups apart but in an experimental study Shaefer (1979) found that English speaking children often overextended these verbs to such events, or assimilated “cutting and breaking” events to the category of *open*. This suggests that the boundaries of the “cutting and breaking” domain itself may not be cognitively obvious, and therefore not universally shared.

We tackle the question of how similar “cutting and breaking” categories are across communities by examining the lexical categories of speakers of diverse languages, the assumption being that distinctions that recur across a range of different languages reflect distinctions fundamental to human cognition. Native speakers of 28 languages were presented with videoclips of “cutting and breaking”, as well as a small set of separation events, and were asked to describe each event just after they had seen it. Their descriptions were then subjected to multivariate statistical analyses in order to ascertain whether there were common patterns of categorization across the languages.

One pattern that could be predicted is a distinction between cutting and breaking events and separation events. Although children make errors between these domains there is a salient physical distinction between these events, in that separation events are reversible while cutting and breaking events are not. Within “cutting and breaking” events, we might expect to see a matrix-like organization – as suggested by Huttenlocher and Lui (1979) analysis of event categories – with some languages focusing on properties of objects, others on instruments, yet others on the manner, etc. This would be in line with previous investigations of cutting and breaking across languages. If this is the case, we would not expect to see universal patterns, rather sub-groups of languages that share principles of categorization. On the other hand, there may be hitherto undiscovered universal principles of categorization.

Method

Participants

Event descriptions were collected from speakers of 28 typologically, genetically and geographically diverse languages, drawn from 23 countries, 13 language families, and a range of cultures (see Table 1). For each language there were between one and seven consultants (*M* = 3.25). Twenty-four researchers collaborated in this effort, all of them experts on the language they studied.

Materials

The data were collected using a set of 61 videoclips, which varied in length (*M* = 9, *SD* = 7, range = 1-34 seconds), and depicted a wide range of events (Bohnemeyer, Bowerman, & Brown 2001). The selection of events was influenced by previous work on cross-linguistic categories of cutting and breaking by Pye (1996; Pye et al., 1995) since it highlighted potentially important distinctions to test that went beyond those manifest in English, and other familiar Indo-European languages. The core set of videoclips depicted a state-change event in which an actor destroyed an object's material integrity. Stimuli were varied along a number of parameters, including the agent, instrument, object acted upon, and manner of destruction (see Appendix). Male and female agents appeared in clips, except in four where the object appeared to be separating spontaneously (e.g. a piece of cloth was shown, and then synchronized with the sound of tearing while the cloth slowly separated into two parts).[3] Instruments included hammers, bladed instruments such as an axe, chisel, knife, machete, saw, scissors, and the use of the hands in a number of different ways, e.g. pulling, karate-chopping. Objects were rigid (e.g., carrot, pot) or flexible (e.g., cloth, rope), one-dimensional (e.g., rope, carrot), two-dimensional (e.g., cloth, plate), or three-dimensional (e.g., melon, pot), etc. Manner of destruction was varied by having actors act on the objects once or repeatedly, and calmly or furiously.

We also sampled events outside this core set of "cutting and breaking" events, with an additional 14 videoclips depicting separation without material destruction (see Appendix), for instance, opening a teapot, opening a door, and pulling paper cups apart. Still others depicted "peeling" events, which share properties with events of both material destruction and simple separation.

[3] These clips were included to address questions about the argument structure of cutting and breaking verbs (see Bohnemeyer, in press).

Table 1: Language details and associated researchers

Language*	**Language affiliation**	**Country**	**Researcher**
Biak	Austronesian	Indonesia	W. van de Heuvel
Chontal*	Isolate	Mexico	L. O'Connor
Dutch*	Indo-European	Netherlands	M. van Staden
English*	Indo-European	UK, USA	M. Bowerman, A. Majid, C. Wortmann
Ewe*	Niger-Congo	Ghana	F. Ameka
German*	Indo-European	Germany	M. van Staden
Hindi*	Indo-European	India	B. Narasimhan
Jalonke*	Niger-Congo	Guinea	F. Lüpke
Japanese	Isolate	Japan	S. Kita
Kilivila	Austronesian	Papua New Guinea	G. Senft
Kuuk Thaayorre*	Pama-Nyungan	Australia	A. Gaby
Lao*	Tai	Laos	N. Enfield
Likpe	Niger-Congo	Ghana	F. Ameka
Mandarin*	Sino-Tibetan	China	J. Chen
Miraña	Witotoan	Colombia	F. Seifart
Otomi*	Otomanguean	Mexico	E. Palancar
Punjabi	Indo-European	Pakistan	A. Majid
Spanish	Indo-European	Spain, Mexico	M. Bowerman, E. Palancar
Sranan*	Creole	Surinam	J. Essegbey
Swedish*	Indo-European	Sweden	M. Gullberg
Tamil*	Dravidian	India	B. Narasimhan
Tidore*	West Papuan Phylum	Indonesia	M. van Staden
Tiriyó	Cariban	Brazil	S. Meira
Touo	Papuan Isolate	Solomon Islands	M. Dunn, A. Terrill
Turkish	Altaic	Turkey	A. Özyürek
Tzeltal*	Mayan	Mexico	P. Brown
Yélî Dyne*	Papuan Isolate	Papua New Guinea	S. Levinson
Yukatek	Mayan	Mexico	J. Bohnemeyer

* Detailed description of the semantics and syntax of cutting and breaking verbs in asterisked languages can be found in Majid & Bowerman (in press)

Procedure

Consultants saw one videoclip at a time in a fixed order on a laptop. The consultants' task was to describe what the agent did.[4] After free description, they were asked what other descriptions could be applied felicitously to each clip, and probed for other information relevant to the argument structure of the verbs. These additional data will not be described here; only the free descriptions of the videoclips are considered.

Data collection was carried out in the language being studied, a crucial point to ensure that descriptions were not influenced by a contact language. All sessions were audio- or video-recorded, for later transcription.

Coding

We defined the target event we were interested in as the change in an object from a state of integrity to a state of separation or material destruction. For each of the languages, the researcher who collected the data identified those constituent(s) of a speaker's description which encoded the event. For example, the event of "a boy cutting a rope" can be expressed in English as *The boy cut the rope*. Here, the caused state-change event is expressed solely by the transitive verb *cut*. The coding was iteratively refined until all researchers had comparable constituents identified. This process was necessary to ensure that apples were not being compared with oranges. For instance, in many serial verb languages (e.g. Ewe, Kilivila, Likpe), description of the cutting and breaking event included mention of the sub-event of taking control of the instrument – even if the instrument was already held by the agent. The verbs used to describe this component of the event were not included in this analysis since they are referring to a sub-event not core to the separation/material destruction and speakers of many other languages never described this sub-event.

[4] For clips that did not depict a visible agent, participants described what happened to the object.

Even restricted to the core event, languages differ in whether information about the state change is typically located in a single verb, as in the English example above, or is spread out across a number of constituents, such as additional verbs, prefixes, particles, etc. For example, speakers of Mandarin use compound verbs to describe many of the events; e.g., *qie1-duan4* 'cut.with.single.blade-be.broken (of long thin object)' for the same event of cutting a rope. In some cases the state change was not entailed by the verb alone (e.g., English *pull (off)*, Dutch *kapot* 'hit'). These cases were included in the analysis since they were still felicitous descriptions of the event. Here we focus on how the stimuli were categorized by the *verbs* of a language, leaving aside the question of how the other parts of speech categorize these events.[5]

Results

Speakers' event descriptions can be treated as analogous to data obtained in sorting tasks designed to study categorization. In a typical sorting task, a participant might receive a set of cards, each depicting a different item, and be asked to sort them into groups of similar items. Speakers in the present study were simply asked to describe what they saw in the videoclips. But each different verb they applied to the target events was taken to define a category or 'group'. Across speakers (both within and across languages), events that are often described with the same verb ('are sorted into the same group') can be taken to be more similar to each other than events that are described by different verbs (Bowerman, 1996). Multivariate statistics can then be used to explore the similarity structure of the data set as a whole. These techniques provide quantitative measures of similarity, but they also provide a way to visualize the overall patterns of categorization. For example, stimuli that are similar to one another (sorted in the same group, described by the same word) can be plotted close to

[5] See Majid, Bowerman, van Staden, & Boster (2007) for further discussion about the linguistic encoding of events across languages.

one another in space; stimuli that are different (never sorted in the same group, never described by the same word) can be plotted further away in space. This way patterns of categorization can be visually represented into a reduced dimensional space.

The first step towards using such statistics is to transform the event-naming data for each language into a similarity matrix. This was done by determining, for all possible pairs of videoclips, whether the pair was ever described by the same verb by any speaker of that language. If so, the pair was assigned a similarity score of one; if not, zero. This procedure was adopted so as not to bias the results toward the categorization schemes favored by languages for which we happened to have more speakers, as could have occurred if we had used a more graded approach to similarity based on the number of speakers within each language who used the same description.

In order to examine how similar semantic categories of “cutting and breaking” are across languages, we first conducted a correspondence analysis, which extracts the main dimensions of differentiation across languages. Next we examined how well individual languages correspond to the general structure we uncovered, and compared the overall categorization system of each language in order to quantify how much of the semantic space for “cutting and breaking” events is shared across languages. Finally, we examined what the most common groupings of “cutting and breaking” events there were across languages.

Shared dimensions of similarity?

To extract the common patterns of categorization across languages – if any – we used correspondence analysis (Greenacre, 1984). Correspondence analysis provides a dual factoring of a rectangular matrix in which columns and rows are projected into the same low dimensional space. The similarity matrices from each of the languages were stacked to build a matrix with 61 columns (the stimuli) and 28*61 (language*stimuli) rows. This matrix was submitted to correspondence analysis to find the dimensions that are the most important in structuring the similarity space of “cutting and breaking” events across languages. Dimensions are extracted in order of importance with the first dimension accounting for the most variance in the data, the second the next most, and so on. Each videoclip is positioned in this multidimensional space in such a way that the distance between any two videoclips reflects the degree to which they are described with the same verbs across languages. Videoclips often described with the same verb are positioned close together, while clips that are rarely or never described with the same verb are far apart.

The first seven dimensions from the correspondence analysis are those that are most important in understanding how people categorize the events presented to them, as can be seen in Figure 1. Overall, 62% of the variance can be accounted for by these seven dimensions; the eigenvalues of the remaining dimensions form a “scree-slope”, indicating uninterpretable noise. As hypothesized in the introduction, languages distinguish between events that are non-reversible, roughly cutting and breaking events (shown in normal font in the Appendix), from events that are reversible, roughly opening events (shown in italics in the Appendix). “Peel” and “take apart” clips were not plotted with either the opening or cutting and breaking clips. Although the two “peel” clips were plotted separately, they were closer to the “cutting and breaking” cluster than the “opening” cluster. This first dimension accounted for 21% of the variance. The second dimension distinguished only the event of pushing a chair away from a table, and the third dimension distinguished peeling events from all other events. Thus, our core “cutting and breaking” events were distinguished from the separation events within the first three dimensions, revealing that across languages material destruction events form a coherent semantic set that is distinct from other events of separation.

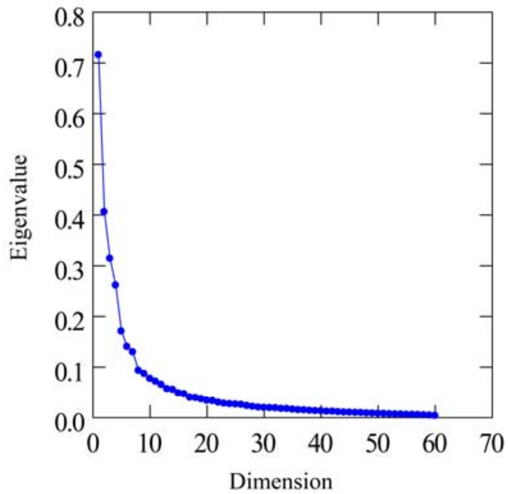

Figure 1: Eigenvalues for correspondence analysis of all videoclips.

Because our main interest is in the semantic categorization of "cutting and breaking" events themselves (assuming that these are a distinct domain from separation events), we subjected the core "cutting and breaking" events to a second correspondence analysis, excluding the other separation events as well as the four non-agentive "cutting and breaking" events.[6]

The first four dimensions of this second correspondence analysis are important in understanding the similarity space of "cutting and breaking" events, as shown in Figure 2. These four dimensions account for 47% of the variance.

[6] In separate analyses we have shown that these verbs are positioned in space with their agentive counterparts.

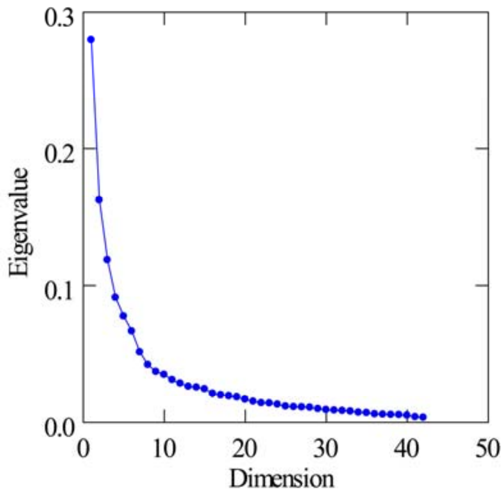

Figure 2: Eigenvalues for correspondence analysis of “cutting and breaking” videoclips.

The first and most important dimension is a continuous one that is not adequately captured by any single feature, contrary to what might be expected (see Figure 3 for a plot of Dimension 1, horizontal axis, against Dimension 3, vertical axis). For example, use of a tool is not predictive of Dimension 1, since we find events involving tools along the whole dimension: clips with instruments appear at both ends of the dimension; clips with use of hands alone are in the middle of the dimension (e.g., “tearing” events, “karate-chopping” events etc.), as well as at the end (e.g., “snapping”), etc. Nor is the dimension defined solely by the characteristics of the objects acted on, since the same objects are distributed across the plot: events involving rigid objects (e.g., carrots, pots, plates, etc.) can be found at either extreme; or to take a specific object, carrots were used in clips 21, 32, 54, 43, 6, 37, 9, and 10, spanning the entire dimension.

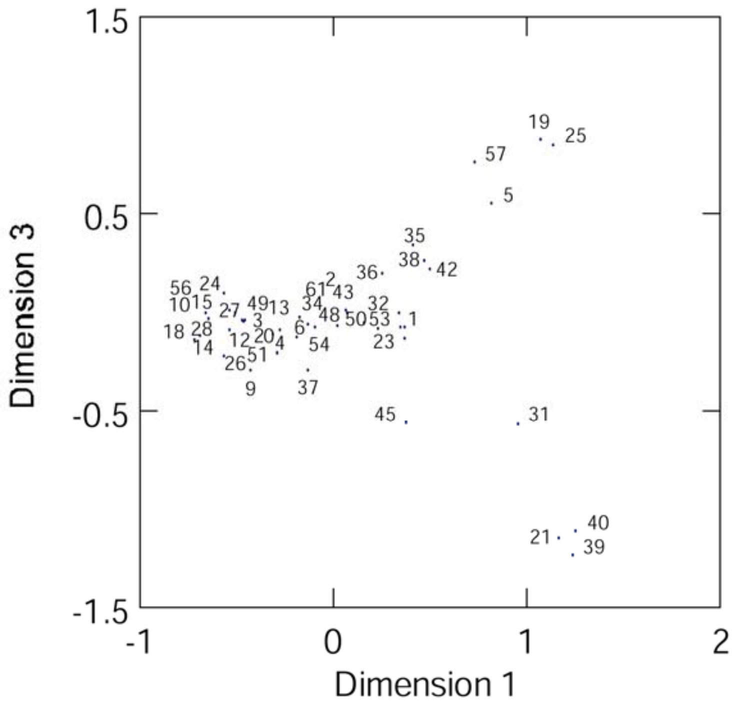

Figure 3: Plot of Dimensions 1 and 3 of correspondence analysis of “cutting and breaking” verbs.

This is not to say that there are no regularities in how features are distributed across Dimension 1: certain *combinations* of features appear to determine the exact positioning of the stimuli. The underlying motivation for these feature combinations is a more abstract notion of predictability, or more precisely, how predictable the location of separation is in the object. Events with relatively high predictability, such as slicing a carrot with a knife (clip 10), are on the left. In these videoclips, the location of separation is predictable since the separation will occur exactly where the knife is placed. Events with relatively low predictability, such as breaking a stick with the hands (clip 19), are on the right. In this case the agent exerts force on both ends of the stick to produce a separation, but the exact point along the stick where the separation will occur cannot be known in advance, and there may even be multiple fractures. Events intermediate in predictability, such as karate-chopping a carrot (clip 32), are in between: the carrot will separate wherever the edge of the hand falls, but the precise point of contact between the hand and the carrot can only be predicted within some margin of error.[7]

So although no single feature can predict the plotting of a videoclip, there are constraints in their placement. For example, using a knife to slice a rigid object, such as a carrot, in a deliberate manner (e.g., clip 10), will lead to a more predictable locus of separation than using an axe to cut a carrot (e.g., clip 37) since the placement of the blade – and the consequent separation – is under more control in the former event. Similarly, using a hammer to produce a division in a rope (clip 50) will lead to a more predictable locus of separation than using a hammer on a pot (clip 39), since the rope will separate in one place, whereas the pot may disintegrate into many pieces. Thus, we are more likely to see bladed instruments to the left of Dimension 1 and blunt instruments to the right because sharp instruments applied in a canonical way give rise to a more predictable locus of separation.[8]

Events intermediate on Dimension 1 are treated variably across languages, with some languages grouping them with the “precise control” events positioned to the left, others with the “imprecise control” events positioned to the right, and still others assigning them to a distinct category. For example, speakers of Chontal (a language isolate of southern Mexico) group the carrot-cutting clip (10) together with the karate-chopping clip (32), using the verb

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[7] The videoclips in this analysis all depicted an agent, so predictability corresponds closely to how precisely the agent controls the locus of separation. In preliminary investigations (Majid, van Staden, Boster, & Bowerman, 2004) we discussed this dimension in terms of control. Here we emphasize predictability rather than control, however, because the verbs associated with a particular region of Dimension 1 are applicable even when the agent acts unintentionally (e.g., accidentally cutting a finger, videoclip 18).

[8] We stress that the it is not bladed versus blunt instruments that are crucial; for example, predictable separation can also be brought about by laser technology.

tek'e- 'cut/break' for both, but a different verb, *tyof'ñi* 'break', for the stick-breaking clip (19). Speakers of Hindi, in contrast, group the stick-breaking clip together with the karate-chopping clip, describing both with *toD* 'break', but use a different verb, *kaaT* 'cut', for the carrot-cutting clip. A third pattern is exemplified by Jalonke (a Niger-Congo language spoken in Guinea), whose speakers distinguish each clip from the other two: *i-xaba* 'cut into sections' for the carrot-cutting clip, *i-gira* 'break' for the stick-breaking clip, and *sɛgɛ* 'cut in one stroke' for the karate-chopping clip.

Dimension 2 distinguishes only two videoclips from the rest – both clips feature an agent tearing a piece of cloth with the hands, either completely (clip 1) or partially (clip 36). These events were labeled *tear* in English, as distinct from *cut* and *break*. Ten out of the 28 languages have a verb that was used to refer to these and only these videoclips; the remaining languages grouped these clips variably with other clips. A common pattern was to group them with other clips involving the material destruction of cloth, but with different instruments. In another pattern (English, German, Dutch) the verb used for tearing cloth (clips 1 and 36) was also extended to pulling yarn apart (clips 35 and 38). Finally, Otomi speakers used the same verb to describe cloth and yarn separation events as well as all rope separation events, however these separations were effected (e.g., also with scissors; clips 2, 49, 50 and 61). Other of our languages have more unusual categories. For example, in Miraña (a Witotoan language spoken in Colombia) a single verb is used for videoclips 1 and 36 and five other clips, all of which involve destruction with a sharp blow (e.g., chopping cloth with a hammer, clip 23; chopping a melon with a sharp blow of a machete, clip 51; smashing a plate with a pot, clip 39). In Yélî Dyne (an Isolate spoken in Papua New Guinea) the verb used for the two "tearing" events is also used for three carrot-cutting events (clips 37, 9 and 43), all of which depict an object being severed along the grain.

Among the events distinguished on Dimension 1 as being low in predictability for the location of separation (to the right in Figure 3), Dimension 3 makes a further distinction between events of “snapping” versus “smashing”. The “snapping” cluster comprises events in which a one-dimensional rigid object is separated into two pieces by application of pressure to both ends (clips 25, 19, 57, 5), while the “smashing” cluster is made up of events in which a rigid object is fragmented into many pieces by application of a blow, e.g., with a hammer (clips 40, 39, 21, 31; see Figure 3). As with Dimensions 1 and 2, there are variations in the exact distinctions made by individual languages. While speakers of Likpe obligatorily observed the Dimension 3 “snapping”-“smashing” distinction, colloquial Tamil speakers collapsed these two categories (along with a few additional clips) into a single event type, denoted by the verb *oDai*, and English speakers made this distinction optionally, some distinguished the clips with *snap* and *smash*, while others grouped them together as instances of *break*.

Dimension 4 distinguished only one scene from the others – poking a hole in a piece of cloth which is tautly stretched between two tables (clip 45). Some languages have a verb which was used only for this clip (e.g., Ewe, Japanese, Jalonke, Kilivila, Likpe, Mandarin), while others used the same verb for other clips too. Both English and Kuuk Thaayorre speakers used a verb for this event and clip 43, in which a person divides a carrot in two using a chisel – in English, the verbs *stab* and *bodge* were used. Other languages, such as Dutch, German and Punjabi, did not distinguish clip 45 at all; for example Dutch speakers use *hakken* ‘chop’ to describe not only clip 45, but also 2, 3, 4, 6, 12 etc.

To summarize, “cutting and breaking” events can be considered a semantic domain distinct from other types of separation events. Within the set of “cutting and breaking” events we find that there are recurring patterns of categorization found across languages: a small number of dimensions capture the distinctions made by languages, and these dimensions account for about half of the variance in this dataset. The first and most important dimension is a continuous one that distinguishes between events on the basis of the predictability of the location of separation in the affected object. The second dimension distinguishes events of “tearing” from all other events. The third dimension makes a further distinction among the set of events where the location of separation is unpredictable, separating “snapping” events from “smashing” events. Finally, the fourth dimension distinguishes “poking a hole” in a piece of cloth from other scenes.

Although we find differences in the precise categories recognized by the languages, these differences are highly constrained by these four dimensions. No language has a verb that groups together events at one end of a dimension with events at the other end, without also applying to events in the middle. Across the 28 languages studied, the semantic categories of cutting and breaking pick out adjacent clips in the restricted four dimensional space.

A General Solution, or Averaging? Before accepting the above conclusion – that the semantic space of cutting and breaking is highly constrained cross-linguistically – it is important to rule out a possible alternative proposal. Perhaps languages actually vary radically and the dimensions discussed above are mere statistical averages that do not reflect individual language structure. To address this possibility we correlated each dimension extracted by the general solution with the dimensions extracted from each language individually, as shown in Table 2. If each language is, in fact, categorizing events differently to every other language, correlations between languages and the general dimensions (discussed in the previous section) should be low. On the other hand, if there are common patterns of categorization that recur across languages, solutions extracted for the individual languages should correlate highly with those extracted when all the languages are taken together.

Overall, the individual languages correlate well with the four main dimensions of the general solution; this is shown by the high mean correlations and the relatively small standard deviations. As we proceed to later extracted dimensions, mean correlations go down and standard deviations go up – this follows from the analysis itself, since earlier dimensions are extracted earlier precisely because they account for more of the variance. Note that distinctions captured by earlier extracted dimensions are honored in more languages than later dimensions. All languages correlate well with the first dimension, but by the time we get to the third dimension there are some languages that do not correlate highly at all.

Languages that correlate highest with Dimension 3, such as Kilivila, Otomi and Biak, never use the same verb for a "snapping" and a "smashing" event. Languages with intermediate correlations, such as English and Turkish, have a general "break" verb that collapses "snapping" and "smashing" events, as well as more specific verbs that distinguish between them. Languages with low correlations either do not distinguish between "snapping" and "smashing" events, but instead use a general "break" verb (i.e., Hindi, Punjabi, Tamil, Yélî Dyne and Sranan), or make a distinction that cross-cuts that of the dimension. This is the case for Chontal, which has the lowest correlation on Dimension 3. It does not have distinct "snapping" and "smashing" verbs. The verb *pay*, a general "break" verb, collapses the distinction between videoclips 25, 57 ("snap") and videoclips 31, 39, 40 ("smash"). A different verb, *tjof'* makes the cross-cutting distinction. It is used for all "snapping" event (but not "smashing" events), and also encompasses "non-snapping" events involving separation in a 1-dimensional object, such as cutting ropes and twigs.

Overall, the independently derived dimensions of our sample of 28 languages correlate extremely well with dimensions in the general solution, consistent with the hypothesis that languages are making similar sorts of distinctions in the cutting and breaking domain.

Table 2: Correlations of each of the 28 languages on the four main dimensions extracted by correspondence analysis

Language	Dimension			
	1 "predictability"	2 "tear"	3 "snap-smash"	4 "poke a hole"
Biak	.90	.75	.89	.81
Chontal	.81	.92	-.04	.19
Dutch	.78	.88	.64	.55
English	.93	.93	.48	.63
Ewe	.80	.70	.89	.70
German	.82	.77	.77	.51
Hindi	.89	.57	.20	.59
Jalonke	.88	.81	.87	.83
Japanese	.60	.90	.53	.81
Kilivila	.94	.71	.95	.91
Kuuk Thaayorre	.93	.95	.76	.89
Lao	.60	.53	.73	.48
Likpe	.77	.45	.85	.78
Mandarin	.79	.75	.79	.81
Miranya	.83	.67	.57	.15
Otomi	.93	.68	.91	.66
Punjabi	.86	.94	.08	.21
Spanish	.79	.61	.60	.36
Sranan	.85	.95	.04	.74
Swedish	.89	.91	.70	.73
Tamil	.82	.92	.19	.62
Tidore	.75	.94	.82	.81
Tiriyo	.83	.97	.88	.74
Touo	.83	.87	.70	.50
Turkish	.88	.62	.43	.14
Tzeltal	.84	.88	.89	.74
Yélî Dyne	.81	.62	.20	.68
Yukatek	.93	.83	.90	.81
Mean	.83	.79	.62	.62
S.D.	.09	.15	.30	.23
Minimum	.60	.45	-.04	.14
Maximum	.94	.97	.95	.91

Further evidence for a general solution. In the previous section, we have shown that individual languages correlate well the four dimensions extracted by the correspondence analysis, however these four dimensions only capture half of the variance in the overall dataset. It could be argued that we have inflated the consistency across languages by discarding the remaining data. In order to capture how similar languages are in their overall categorization patterns, we can use the factor-analytic methods described by Romney, Weller, and Batchelder (1986). In this technique, the entire similarity matrices of individuals – or languages – can be compared, and a measure of agreement extracted.

To conduct the analysis, the videoclip-by-videoclip similarity matrices based on the 28 languages were correlated with each other, and the resulting correlation matrices were factor-analyzed using both principal components analysis (PCA) and minimal residual factor analysis (MRFA). If there is strong similarity in the way the languages categorize events, languages will correlate positively with each other and factor scores on the first factor will therefore be positive too. If some languages do not share a pattern of categorization they will correlate negatively with the other languages, and will thus load negatively on the first factor. The strength of the agreement between languages can be assessed by the size of the eigenvalues. If the eigenvalue of the first factor is large in comparison to subsequent eigenvalues then there is more common structure across languages (see Boster & Johnson, 1989).

Overall correlations of the 28 languages to each other are given in Table 3. Both factor-analytic methods gave effectively identical results, as indicated in Figure 4, so we restrict our discussion to the PCA model.

Table 3: Mean, standard deviation, minimum and maximum correlations of the overall similarity matrices for “cutting and breaking” events

	Pearson r	PCA	MRFA
Mean	0.53	0.53	0.51
S.D.	0.14	0.15	0.15
Minimum	0.09	0.04	0.04
Maximum	0.71	0.72	0.71

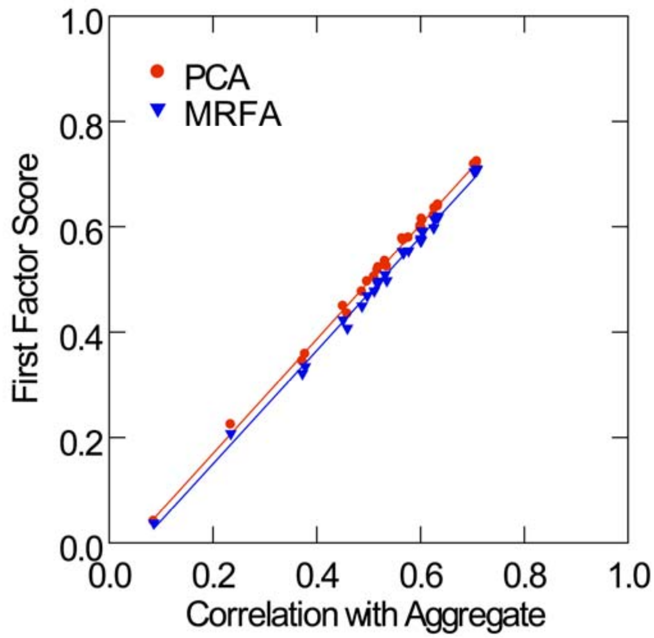

Figure 4: Correlation of first factor scores and the aggregate for individual languages in PCA and MRFA .

Figure 5 shows a plot of the first two factors. Each language is plotted in the figure on the basis of how similar it was to the other languages in its overall similarity matrix, i.e., its overall pattern of categorization for the “cutting and breaking” videoclips. The more similar two languages were in how they classified the clips the closer together they are plotted in space. The first factor is the one that taps common structure across languages (if any). This can be interpreted as an “agreement” dimension – if languages agree with one another in how they categorize these clips then they will load positively on this factor. The second factor begins to show how languages differ from one another, and can be interpreted as a “differentiation” dimension.

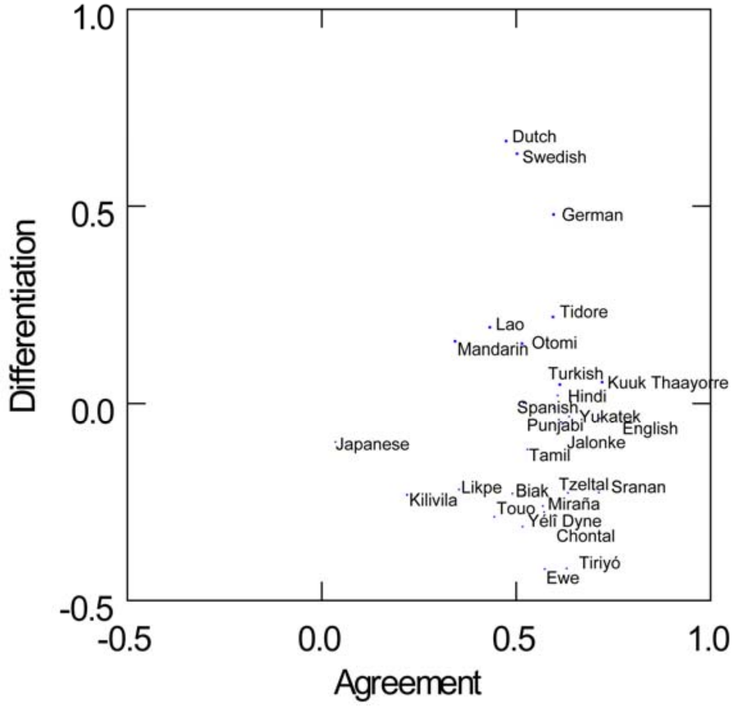

Figure 5: Agreement and differentiation amongst languages in their overall classification of "cutting and breaking" events.

Consistent with the hypothesis that there is shared structure across languages, no language loaded negatively on the first factor; the lowest score was .02 for Japanese, followed by .11 for Kilivila. A closer examination of these languages shows that the low agreement is not because these languages have categories that are at odds with the ones found in the other languages, but because the data matrices for these languages are sparse. Data for both languages came from only one participant, and there were missing responses for some of the events. In addition, Japanese and Kilivila speakers used a large number of verbs unique to a single videoclip, in comparison to speakers of other languages, which means that relatively few of the clips were categorized together. Further research is necessary to determine whether the anomaly of these two languages would persist if the languages were better sampled.

The second criteria for establishing shared structure is that the first eigenvalue should be large in comparison to all other eigenvalues. Consistent with the shared structure hypothesis, the eigenvalue for the first factor (8.52) was four times larger than the eigenvalue for the second factor (2.15), and accounted for 30% of the variance. This means that the amount of shared structure in the data is far greater than the amount of difference.

Most common category groupings

We have shown that languages agree with one another in how they categorize events of "cutting and breaking" and that there are a common set of semantic dimensions that characterize how the verbs of different languages apply to these events. However, while respecting these dimensions languages could still have myriad different solutions of which clips to group together which other clips. The four dimensions of the correspondence analysis – "predictability", "tearing", "snapping"-"smashing", and "poking a hole" – produce the constraint that clips adjacent to one another are grouped together, but still many different groupings are possible. This raises the question of whether there are some groupings of events which are more common across languages than others. In order to address this question, we submitted the stacked similarity matrices from all 28 languages to an agglomerative cluster analysis, using average link and binary Euclidean distance for similarity. Figure 6 shows the main clusters across languages. Note that this is a "winner-takes-all" plot – clusters are defined by groupings that are most common across languages, so not all individual language groupings will be faithfully depicted – but the most common strategies can be seen.

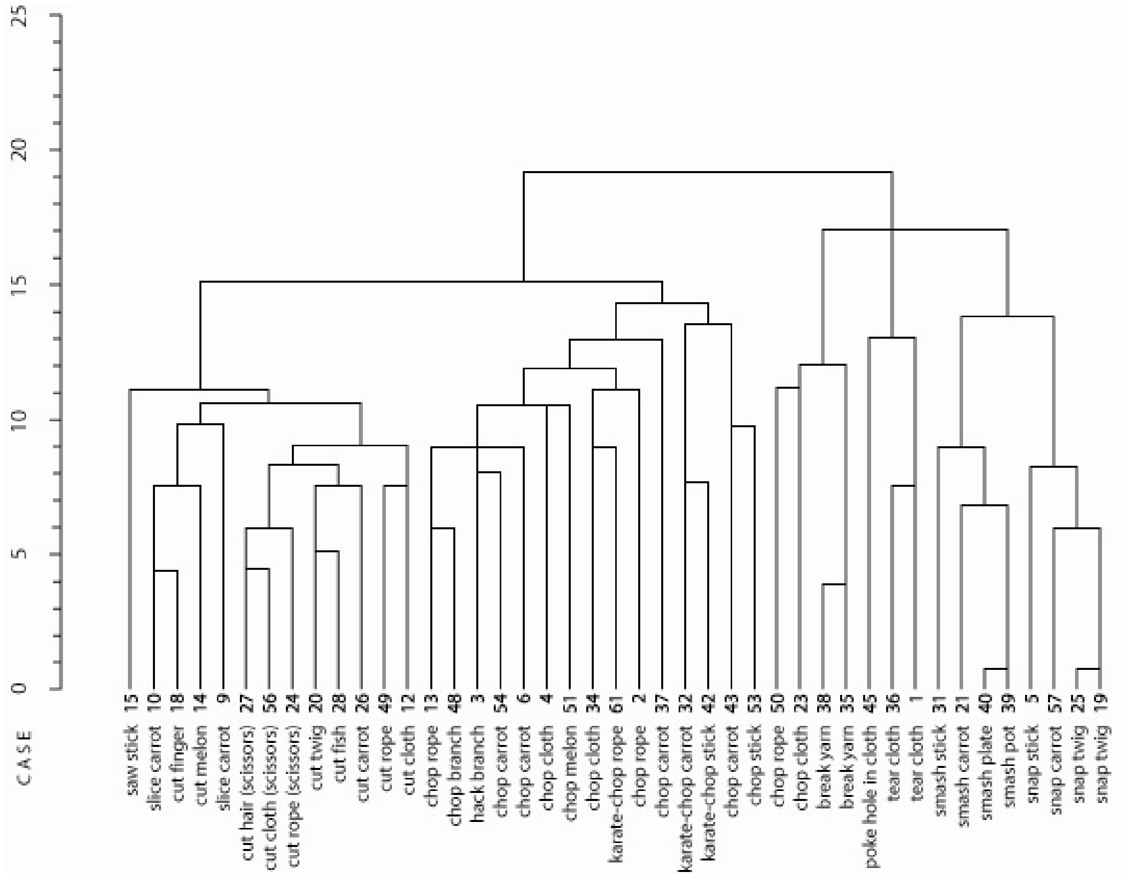

Figure 6: Dendogram of cluster analysis based on all languages semantic categorization of “cutting and breaking” events.

The dendogram in Figure 6 can be thought of as a “hanging mobile”, with the leaves of the mobile identifying videoclips (see Appendix for full description of clips). The clusters can be rotated on the pivot at the top while maintaining the structure. We have rotated the clusters on the pivots in order to mirror, as closely as possible, the order of the videoclips in Dimension 1 of the correspondence analysis – high predictability events are on the left of the figure, low predictability events on the right. There are two major clusters uncovered by the analysis, corresponding to roughly “cutting” events – higher in predictability – and “breaking” events – lower in predictability. Most languages group intermediate predictability events, such as karate-chopping a carrot, with the “cutting” events. This suggests that the Chontal strategy, discussed earlier, of grouping karate-chopping events with fine precision cutting events is relatively more common cross-linguistically, while the Hindi strategy of grouping these events with the breaking events is relatively unusual.

The other interesting aspect of the “cutting” cluster is the sub-group of “cutting-with-scissor” events. A few languages in our sample, such as Dutch, Swedish and Mandarin, have an obligatory distinction between “cutting-with-single-blade” and “cutting-with-double-bladed-instrument”, such as scissors but also including nail clippers, etc. This distinction was not apparent in the correspondence analysis, since many languages do not differentiate these events with distinct verbs.

Within the “breaking” cluster, we see three major sub-clusters. The right-most cluster consists of “snapping” events and “smashing” events – a distinction made on Dimension 3 of the correspondence analysis, and respected by most languages. The next big major cluster includes “tearing” events – distinguished on Dimension 2 of the correspondence analysis – and the one “poking a hole in fabric” event – distinguished on Dimension 4. The last cluster includes some of the “chopping” events. Although most of the “chopping” events are grouped with the “cutting” events, these clips are pulled into this cluster because they involve separation of flexible objects. There is a tendency across languages to use the “tearing” verb for other flexible objects and so clips involving such objects get grouped together. This same tendency means that clips 1 and 36, which depict tearing a piece of cloth with the hands, gets grouped with clip 45, poking a hole in cloth, get grouped – because they share a verb in some languages.

Discussion

Speakers of a variety of typologically, genetically and geographically diverse languages agree to a considerable extent in their linguistic categorization of events involving the material destruction of objects – “cutting and breaking” events. First, they agree on treating such events as a relatively coherent semantic domain. It is not obvious, a priori, that languages will always used distinct verbs for “cutting and breaking” events as opposed to events involving other kinds of separation, such as “taking apart”, “opening”, and “peeling”; after all, learners of English make a number of errors that suggest the boundaries of these event types are not obvious (Bowerman, 2005; Schaefer, 1979). We found that other “reversible” separation events, such as opening the eyes or removing a lid from a teapot, were rarely described with the same verbs that were used for the core set of “cutting and breaking” events. “Cutting and breaking” events were treated as far more similar to each other than they were to the other kinds of separations, in the sense that they were much more often described with the same verbs.

Second, speakers of different languages also showed considerable agreement in the kinds of distinctions they made within the domain of “cutting and breaking” events. Although they ranged from industrial urban-dwellers to rainforest-dwelling swidden agriculturists, and used different tools and techniques for cutting and breaking, they converged to a surprising extent on a shared recognition of the similarities and differences among events of “cutting and breaking”. For example, speakers of Yélî Dyne inhabit the easternmost island of the Louiseade Archipelago in Papua New Guinea – an extremely remote location. Steel tools, such as knives and axes, were not introduced to the island until the early 20th century. Prior to this, there were no sharp instruments; the island is basalt and there was no stone suitable for making cutting tools. Yet, despite this difference in cultural ecology, Yélî Dyne still correlates extremely well with the pattern of categorization found in other languages in our sample (see Table 2; cf. Levinson, in press).

The basis of categorization for the “cutting and breaking” domain does not appear to be any simple feature – such as object, instrument, or manner – but rather more abstract constellations of features. The most important of these was the predictability of the locus of separation in the object. Events where the locus of separation was highly predictable, roughly "cutting" events, were distinguished from events where the locus was not very predictable, roughly "breaking" events (Dimension 1). Further, "tearing" events were very often distinguished from other events with intermediate predictability in the locus of separation (Dimension 2), while among events with low predictability, "snapping" and "smashing" events were often distinguished (Dimension 3). Finally, piercing a hole into a cloth with a twig often received a unique verb within this set of "cutting and breaking" events (Dimension 4).

The observed shared structure across languages belies the assumption, held by many, that languages differ fundamentally in how they categorize events with verbs. According to one proposal open-class items are free to vary as they will (e.g., Bickerton, 1981, 1984; Kemmer, 2003; Pinker, 1984; Slobin, 1985; Talmy, 1985; 1988), predicting that there will be little in common across languages in how they categorize "cutting and breaking" events. According to another, the semantics of verbs – as opposed to nouns – is particularly variable. Nouns typically refer to objects, which have correlated features and thus are highly perceptually salient, but verbs typically refer to events which are said not to have correlated features. Instead, event features are said to be organized in a matrix-like fashion, and are thus not cognitively salient "packages" waiting to be lexicalized with a verb (e.g., Gentner, 1981, 1982; Gentner & Boroditsky, 2001; Huttenlocher & Lui, 1979; Morris & Murphy, 1990).

It is not difficult to find examples of variation. For example, Pye (1996; Pye et al., 1995) has shown that while English *break* is used with a wide range of objects (e.g., a plate, a stick, a rope), K'iche' Maya has much more specific "break" verbs that categorize for specific objects: rock, glass, clay thing, long flexible things etc. But we want to be able to abstract away for individual examples and establish whether there are nonetheless constraints to event naming. Our analyses suggest that there is considerable constraints in the semantic categories for at least one set of events, namely “cutting and breaking” events. We interpret agreement on the dimensions in the face of disagreement about precisely *which* features are lexicalized in verbs as a consequence of the fact that in the real world features of “cutting and breaking” events are not independent of one another. That is, we reject the proposal that event categories are organized in matrix-like fashion (cf. Huttenlocher & Lui, 1979).

Instead we propose that features of real-world events are highly correlated with one another, with particular kinds of instruments associated with particular objects and specific resulting changes of state. For example, events that are high in predictability for locus of separation will typically include a sharp instrument. It is difficult to control exactly where a separation will occur with a hammer. Successful use of a sharp instrument requires objects with certain characteristics: they cannot be too rigid, brittle or fluid (e.g., a plate, an egg yolk); they have to retain their integrity while the instrument makes contact (e.g., a carrot, a fish, etc.). The agent typically uses the instrument on the object in a deliberate manner – making a sharp blow with an axe on a carrot does not offer as predictable a separation as placing a knife against the object and pressing down. The combination of instrument, object, and agentive deliberateness gives rise to a specific kind of result: two clean and smooth edges on the parts of the original object (in contrast to the ragged edges resulting from “tearing”, “snapping” or “smashing”). The features of “cutting and breaking” events in the real world co-vary, such that separations of carrots are more likely to involve knives than hammers, and separations of plates are more likely to happen with hammers than knives.

Thus, there may be feature clustering for both objects and events, rather than completely different organization principles. Still, there may be differences between objects and events in the strength of the clustering. This would be compatible with the core proposal made by Gentner (1982; Gentner & Boroditsky, 2001) – that event categories are *more* variable than object categories. Consistent with this, Vinson, Vigliocco, Cappa, and Siri (2003) compared correlations amongst features for different types of categories, and found that correlations were higher for objects than for events. Given this clustering of features, there may be perceptual discontinuities in event categories that are crying out to be named just as there are in biological classification (Hunn, 1977; Berlin, 1992). Of course, language communities still have to figure out which features to attend to in order to distinguish these perceptually distinct categories. Some language communities choose to attend more to the characteristics of the object, and others to the characteristics of the instruments, even though these characteristics are likely to co-vary. Thus, even if languages focus on different features, the same overall distinctions may be maintained.

As well as contributing to our understanding of how languages partition and group events of “cutting and breaking”, we believe our findings contribute to understanding how people conceptualize these events in non-linguistic cognition too. We have shown that speakers of incredibly diverse languages share a common semantic space for the verbs in their language, and we suggest that this is due to a common conceptualization of events too. Where there are fine-grained differences in boundaries, and number of categories, there may be scope for subtle differences in non-linguistic conceptualization to emerge, however, the overall conceptual structure looks to be shared across people from different speech communities.

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Appendix

Below are short descriptions of the video stimuli used in this study, designed by Bohnemeyer, Bowerman, and Brown (2001). *Italics* indicates "open", "take apart", and "peel" items that were distinguished by the first factor of the initial correspondence analysis. **Bold** indicates the "spontaneous" actions, which were removed in the analysis of "cutting and breaking" events.

1. Tear cloth into two pieces by hand
2. Cut rope stretched between two tables with single downward blow of chisel
3. Hack branch off tree with machete
4. Chop cloth stretched between two tables with repeated intense knife blows
5. Break stick over knee several times with intensity
6. Chop multiple carrots crossways with big knife, intensity
7. *Push chair back from table*
8. **Piece of cloth tears spontaneously into two pieces**
9. Slice carrot lengthwise with knife into two pieces
10. Slice carrot across into multiple pieces with knife
11. *Pull two paper cups apart by hand*
12. Cut strip of cloth stretched between two people's hands in two
13. Cut rope stretched between two tables with blow of axe
14. Make single incision in melon with knife
15. Saw stick propped between two tables in half
16. **Forking branch of twig snaps spontaneously off**
17. **Carrot snaps spontaneously**
18. Cut finger accidentally while cutting orange
19. Snap twig with two hands

20. Cut single branch off twig with sawing motion of knife
21. Smash carrot into several fragments with hammer
22. *Take top off pen*
23. Chop cloth stretched between two tables into two pieces with two blows of hammer
24. Cut rope in two with scissors
25. Snap twig with two hands, but it doesn't come apart
26. Cut carrot crossways into two pieces with a couple of sawing motions with knife
27. Cut hair with scissors
28. Cut fish into three pieces with sawing motion of knife
29. *Peel an orange almost completely by hand*
30. *Peel a banana completely by hand*
31. Smash a stick into several fragments with single blow of hammer
32. Cut carrot in half crossways with single karate chop of hand
33. *Open a book*
34. Chop cloth stretched between two tables with single karate chop of hand
35. Break yarn into many pieces with fury
36. Tear cloth about half-way through with two hands
37. Cut carrot in half lengthwise with single blow of axe
38. Break single piece off yarn by hand
39. Smash flower pot with single blow of hammer
40. Smash plate with single blow of hammer
41. *Open a hinged box*
42. Break vertically-held stick with single karate chop of hand
43. Cut carrot crossways into two pieces with single blow of chisel

44. *Open canister by twisting top slightly and lifting it off*

45. Poke hole in cloth stretched between two tables with a twig

46. **Rope parts spontaneously, sound of a single chop**

47. *Open hand*

48. Chop branch repeatedly with axe, both lengthwise and crosswise, until a piece comes off

49. Cut rope in two with knife

50. Chop rope stretched between two tables in two with repeated blows of hammer

51. Split melon in two with single knife blow, followed by pushing halves apart by hand

52. *Open mouth*

53. Break stick in two with single downward blow of chisel

54. Cut carrot in half crosswise with single blow of axe

55. *Open teapot/take lid off teapot*

56. Cut cloth stretched between two tables in two with scissors

57. Snap carrot with two hands

58. *Open eyes*

59. *Open scissors*

60. *Open door*

61. Break rope stretched between two tables with single karate chop of hand

Author Note

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