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The cross-linguistic categorization of everyday events: A study of cutting and breaking

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ABSTRACT

The cross-linguistic investigation of semantic categories has a long history, spanning many disciplines and covering many domains. But the extent to which semantic categories are universal or language-specific remains highly controversial. Focusing on the domain of events involving material destruction ("cutting and breaking" events, for short), this study investigates how speakers of different languages implicitly categorize such events through the verbs they use to talk about them. Speakers of 28 typologically, genetically and geographically diverse languages were asked to describe the events shown in a set of videoclips, and the distribution of their verbs across the events was analyzed with multivariate statistics. The results show that there is considerable agreement across languages in the dimensions along which cutting and breaking events are distinguished, although there is 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.

1. 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 recent overviews see Boster, 2005; Evans, in press; Koptjevskaja-sTamm, Vanhove, & Koch, 2007). Classic domains of enquiry include color (Berlin & Kay, 1969), emotion (Ekman, 1972; Ekman & Friesen, 1975), ethnobiology (Berlin, 1992; Berlin, Breedlove, & Raven, 1973), the human body (Andersen, 1978; C.H. Brown, 1976) and kinship (Goodenough, 1956; Lounsbury, 1956). Despite this work, there is still little consensus on the degree to which categorization is constrained across languages by general principles or is relatively free to vary. Universals of nomenclature once thought to have been established are now 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. The outcomes are still to be determined.

A major advance in this debate has been the insistence on collecting data in a standardized way across a wide range of languages and cultures, along with the use of statistical techniques to quantify the extent of agreement across languages (Croft & Poole, 2008; Kay & Regier, 2003; Levinson & Meira, 2003; Regier, Kay, & Khetarpal, 2007). In this paper, we follow this approach in an investigation of the semantic categorization of events of "cutting and breaking". We examine how people describe a standardized set of such events across a typologically, genetically and geographically diverse set of languages, focusing in particular on the implicit categorization of events imposed by the verbs speakers use. We show that despite variation in the number of "cutting and breaking" categories recognized in the different languages, and in the exact

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boundaries of these categories, there is considerable common structure in the data set: the languages 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.

1.1. Events as a domain of enquiry

Categorization is the process by which different entities – objects, events, relationships, properties, etc. – are treated as being "of the same kind" for the purposes of language, memory and reasoning. Thus, a poodle, a snake and an octopus, although they are perceptually quite dissimilar, can be grouped together under the category of "animals".

Although categorization has been studied in a number of semantic domains, the primary focus among psychologists has for many decades been on the representation of objects (Murphy, 2002). Comparatively little work has been done on event categorization (although there has been a noticeable awakening of interest in events in recent years; see the edited volumes by Hirsh-Pasek & Golinkoff, 2006; Shipley & Zacks, 2008; Tomasello & Merriman, 1995). Just as for objects, however, we can ask whether different happenings are viewed as events of the same kind. For instance, is slicing a carrot with a knife the same kind of event as cutting a piece of paper with a pair of scissors (e.g., both "cutting" events)? What about using an axe to chop a branch in two versus smashing a pot with a hammer? And – a critical question – are the answers to such questions largely universal, or do they vary from language to language?

Questions like these have rarely been pursued. Many studies of the linguistic structuring of events have focused on how global meaning elements are characteristically "packaged"– i.e., distributed across the lexical items of a sentence. For example, motion events can be broken down into a number of structural components like the fact of motion, the manner of motion, the path along which the motion takes place and the nature of the moving object. Languages vary in which of these elements are typically expressed in the verb (Talmy, 1985). In English, for example, the verb characteristically expresses both the fact of motion and the manner of motion, with path information expressed in a separate element such as a particle (e.g., *dance in, walk out, stroll over*). In Spanish, in contrast, the verb typically combines information about motion with information about path, and expresses manner optionally in an adverbial (e.g., *entrar bailando* 'go-in dancing'; *salir caminando* 'go-out walking'). Differences like these have been studied extensively from the standpoint of both language acquisition (e.g., Allen et al., 2007; Choi & Bowerman, 1991; Choi, McDonough, Bowerman, & Mandler, 1999; Zheng & Goldin-Meadow, 2002) and the cognitive consequences for event construal and memory (Finkbeiner, Nicol, Greth, & Nakamura, 2002; Gennari, Sloman, Malt, & Fitch, 2002; Kita & Özyürek, 2003; Papafragou, Massey, & Gleitman, 2002, 2006).

In studies of motion events, cross-linguistic similarities and differences in categorization are seldom investigated (see Choi & Bowerman, 1991, for an exception). Rather, it is commonly assumed that categories of path, manner, etc. are largely universal, with cross-linguistic variation revolving around how the elements expressing them are separated or combined in lexical items. There is, however, one recent study that directly addresses categorization for a subtype of motion events, human locomotion (Malt et al., 2008).

Humans have two efficient locomotion gaits – walking and running (Alexander, 1992; Minetti & Alexander, 1997). These gaits can be characterized by a number of parameters such as stride length, the length of time that each foot is on the ground and the time course of the forces exerted on the ground. Walking involves a pendulum-like motion from the hip, where one foot is always in contact with the ground, whereas running involves a bounce-and-recoil motion in which there is a moment when neither foot is in contact with the ground. As speed of bipedal locomotion increases, there is an abrupt transition from walking to running (Diedrich & Warren, 1995). Malt et al. (2008) investigated whether this discontinuity in human locomotion constrains linguistic categorization. That is, they asked whether languages universally honor this discontinuity, categorizing human locomotion according to the gait involved, or instead categorize locomotion in different ways according to language-specific principles.

Japanese, Spanish, Dutch and English speakers were shown videoclips of a woman on a treadmill and asked to describe what she was doing. In all the languages a major distinction was made between the two sorts of gaits, i.e., naming responses showed a categorical distribution for walking and running. This was true for both manner-salient languages like English and Dutch as well as path-(and ground-)salient languages like Spanish and Japanese (see Slobin, 2004, on this distinction). This study demonstrates that languages can share principles of fine-grained event categorization even though they may differ in how they package the components of a motion event.

In this paper, we also investigate fine-grained linguistic event categorization, using a new technique and applying it to a new domain: everyday events involving a "separation in the material integrity" of an object (Hale & Keyser's, 1987, term), or "cutting and breaking" events, for short.[1] In their investigation of locomotion Malt et al. could rely on previous biomechanical analyses in order to hypothesize possible cross-linguistic constraints on gait-naming. But no such analysis exists for events like slicing a carrot with a knife or chopping a branch with an axe. Instead, our research attempts to uncover which parameters are relevant to the categorization of such events.

1.2. Cutting and breaking events

The domain of "cutting and breaking" was chosen in part because its cognitive status is ambiguous: a priori, it

[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 marks point informally to actions of a certain general type, and words in italics designate specific linguistic forms. Single quotes are used to gloss the meanings of words in languages other than English.

seemed equally plausible that event categories in this domain are universal and that they are variable. In favor of universality, the manufacture and use of tools for purposes of cutting and breaking has been dated back at least 2.5 million years to the East African Rift area. 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] Cutting and breaking are practiced in every society and by practically every member of the society; these actions do not require specialized knowledge (although there may, of course, be expert variants of cutting and breaking in a community, such as diamond cutting and quarrying). The fact that cutting and breaking have been central to human activity for so long suggests that there may be a common way of conceiving such events.

Further reason to expect universality comes from linguistics, where cross-linguistic analyses suggest that verbs of cutting and breaking fall universally into two distinct classes, which have systematically different kinds of meanings that correlate with distinct syntactic behaviors (Guerssel, Hale, Laughren, Levin, & White Eagle, 1985; Levin & Rappaport, 1995; but see Bohnemeyer, 2007). These claims suggest that there is a shared human conceptualization of cutting and breaking events, at least at a relatively abstract level.

But there is also evidence for variability in the conceptualization of these events. First is the fact that although cutting and breaking behaviors have been part of the human repertoire since prehistory, their exact manifestation varies according to 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, whereas Punjabi speakers in rural Pakistan and India often move the vegetables against a stationary curved knife. Different practices like these could lead to systematic differences in people's event categories.

Consistent with this view, the extensions of "cutting and breaking" verbs have been claimed to differ considerably across languages (Fujii, 1999; Goddard & Wierzbicka, in press; Pye, 1996; Pye, Loeb, & Pao, 1995). 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 large 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 (another kind of) hard thing' (e.g., a stick); *-t'oqopi:j* 'break a long flexible thing' (e.g., a rope) (Pye, 1996; Pye et al., 1995). Cross-linguistic variation suggests that no one way to categorize "cutting and breaking" events is cognitively obvious or inevitable.

As further evidence for flexibility in the human categorization of "cutting and breaking" events, young children make many errors in verb choice in this domain (Bowerman, 2005; Pye et al., 1995; Schaefer, 1979). In English such errors include, for example, saying *break* for tearing cloth and *cut* for pulling apart a peach slice with the fingers or crushing ice cubes with a rolling pin. Learners of English also often overextend *break/broken* to reversible events like opening a safety pin, undoing overall straps, or separating magnets, and *open* to irreversible events like pulling off a doll's leg or breaking a roll (Bowerman, 2005). This suggests that the boundary between reversible and irreversible separation events might not be honored as systematically in all languages as it is in English.

The existing cross-linguistic evidence on semantic categorization in the domain of cutting and breaking is piecemeal, and limited to a few languages. In the present study, we tackle the question of universality versus relativity in this domain systematically by examining the lexical categories employed by speakers of a wide range of diverse languages in describing a standardized set of events. If certain distinctions or groupings recur across a wide range of languages, it is plausible to assume that these reflect conceptualizations that are fundamental to human cognition.

2. Method

2.1. 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 ($M = 3.25$). The 24 researchers listed in Table 1 collaborated in this effort; all were experts on the language they studied.

2.2. Materials

The data were collected using a set of 61 videoclips depicting a wide range of events (Bohnemeyer, Bowerman, & Brown, 2001). The clips varied in length from 2 to 34 s ($M = 9$, $SD = 7$). The selection of the events shown in the clips was influenced in part by previous cross-linguistic work by Pye (1996) and Pye et al. (1995), which highlighted potentially important distinctions in the domain of cutting and breaking events that went beyond those obvious from English and other familiar Indo-European languages. A second influence was the literature on children's errors of verb use in this domain, in particular the hint, discussed above, that the distinction between reversible and non-reversible separation events may not be cognitively obvious or salient. The final set of videoclips included a "core" set of "cutting and breaking" events involving non-reversible separations, and a smaller set of reversible separations such as "opening a teapot" and "pulling apart paper cups", as well as two "peeling" events which share properties with both reversible and non-reversible events (see Fig. 1; Appendix).

For the core set of videoclips, the stimuli varied along a number of parameters, including the agent, instrument, object acted upon and manner of destruction. Almost all the clips featured an agent, either a man or a woman, but in four clips the object appeared to separate spontaneously

[2] Great apes and monkeys may also engage in cutting with simple stone flakes (Schick et al., 1999; Westergaard, 1995; Wright, 1972), which is consistent with the suggestion that these events have an ancient history in human cognition.

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 Dnye*	Papuan Isolate	Papua New Guinea	S. Levinson
Yukatek	Mayan	Mexico	J. Bohnemeyer

* Detailed descriptions of the semantics and syntax of cutting and breaking verbs in the asterisked languages can be found in Majid and Bowerman (2007).

(e.g., a piece of cloth separates slowly into two parts in synchrony with the sound of tearing).[3] Instruments included hammers, bladed tools such as an axe, chisel, knife, machete, saw, scissors, and the use of the hands in a number of different ways, e.g., pulling and 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). Manner of destruction was varied by having actors act on the objects once or repeatedly, and calmly or intensively.

2.3. 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. Information relevant to the argument structure of the verbs was also elicited. Here, only the free descriptions of the videoclips are considered.

Data collection was carried out entirely in the target language, a crucial point, since it minimizes influence on descriptions from a contact language. All sessions were audio- or video-recorded for later transcription.

[3] These clips were included to address questions about the argument structure of cutting and breaking verbs (see Bohnemeyer, 2007).

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

2.4. Coding

For each clip, we defined the target or core event 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 this event. For example, in English the event of "a boy cutting a rope" can be expressed 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 identified comparable constituents. 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), consultants' descriptions of the cutting and breaking events included mention not only of the state-change but also of the subevent of taking control of the instrument – even if the instrument was already held by the agent at the start of the clip. The verbs used to describe this subevent were not included in the present analysis, since the "taking control" subevent was subsidiary to the main event of separation/material destruction, and speakers of many languages never described it.

Even when we restrict our attention to descriptions of the core event, languages differ in whether information about the state change (the separation) 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, affixes or particles. For example, speakers of Mandarin used compound verbs to describe many of the

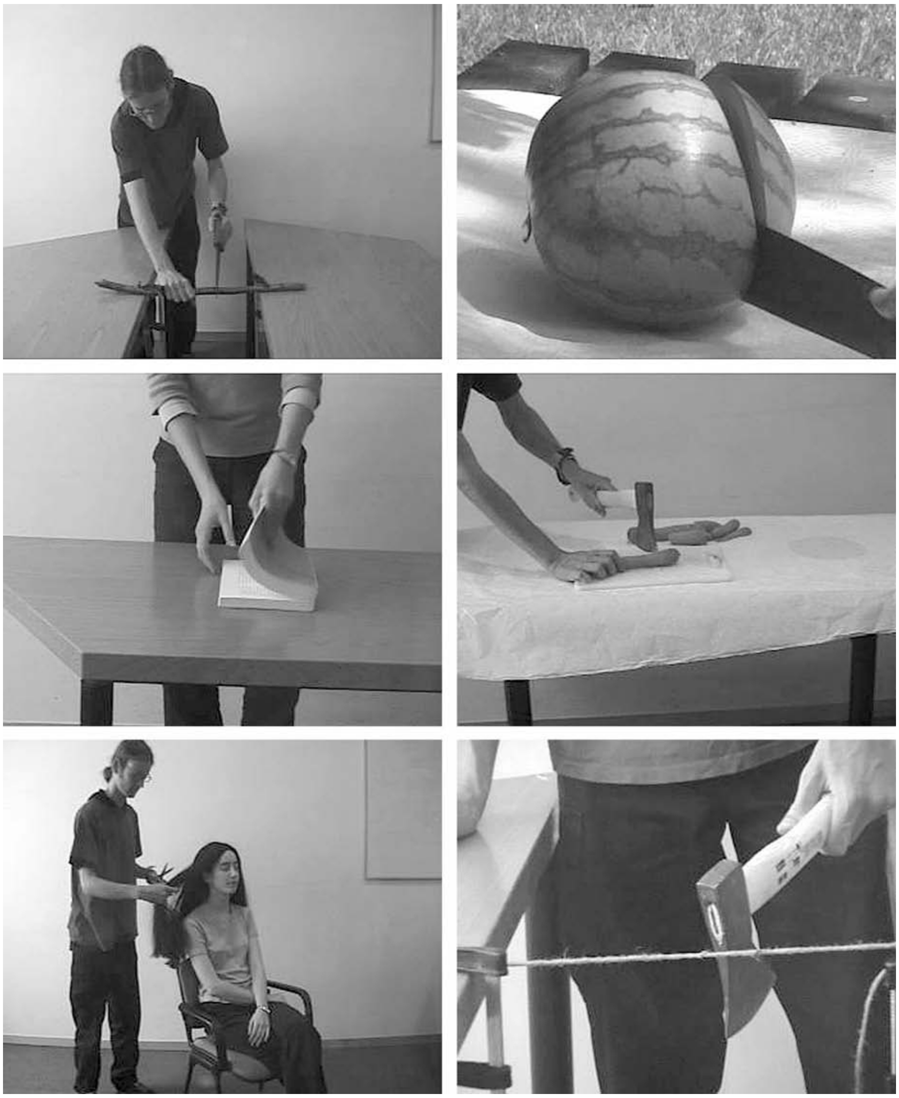

Fig. 1. Some stills taken from the "cut and break" videoclips.

events; e.g., *qie1-duan4* 'cut.with.single.blade-be.broken (of long thin object)' for slicing carrots crosswise. In our analyses we focus only on the categorization imposed by *verbs* (including both verbs of a compound verb), and leave aside the question of how these events are categorized by other parts of speech.[5]

3. Results

Speakers' event descriptions can be treated as analogous to data obtained in sorting tasks designed to study categorization (Bowerman, 1996). In a typical sorting task, a participant might receive a set of cards, each depicting a different item, and be asked to sort the cards into groups of similar items. Speakers in the present study were not asked to sort, but rather simply 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" of events for them. 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 semantically more similar to each other than events that are described with different verbs. Multivariate statistics can be used to explore the similarity structure of the data set as a whole. These techniques provide quantitative measures of similarity, as well as a way to visualize the overall categorization patterns.

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

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

described with 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 assess the similarity of semantic categories of "cutting and breaking" across languages, we first conducted a correspondence analysis, which extracts the main dimensions along which the languages grouped or differentiated events. Next we examined how well individual languages corresponded to the general structure we uncovered, and then compared the overall categorization system of all the languages in order to quantify how much of the semantic space for "cutting and breaking" events is cross-linguistically shared. Finally, we turned to the most common ways of grouping "cutting and breaking" events across languages. These analyses are taken up in turn.

3.1. Shared dimensions of similarity?

Correspondence analysis provides a dual factoring of a rectangular matrix in which columns and rows are projected into the same low-dimensional space (Greenacre, 1984). The input to the current analysis was a stacked similarity matrix with 61 columns (the stimuli) and 28*61 (language*stimuli) rows.

Correspondence analysis extracts dimensions of similarity in order of importance, with the first dimension accounting for the most variance in the data, the second for the next most and so on. In the multidimensional space resulting from such an analysis, a point representing each item is positioned in such a way that the distance between any two items reflects the degree of similarity between those items. In our case, the points represent videoclips,

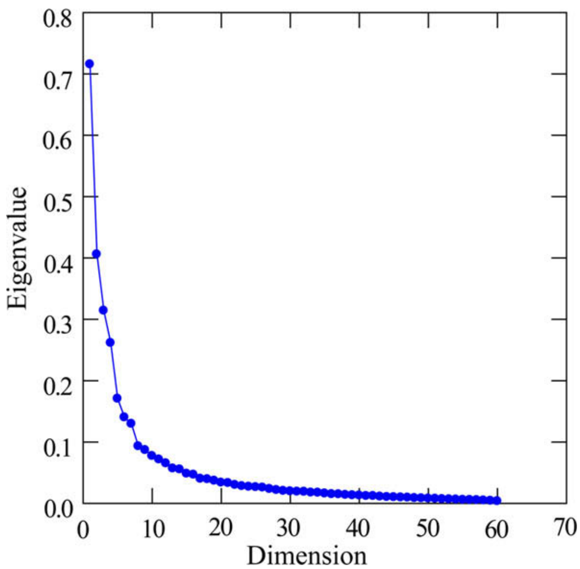

Fig. 2. Eigenvalues for correspondence analysis of all videoclips.

and the positioning of each clip reflects the extent to which, across languages, this clip is described with the same verbs as each other clip. Thus, clips 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.

In this correspondence analysis the first seven dimensions are the most important in understanding how people categorized the events presented to them; this can be seen in Fig. 2. Overall, these dimensions account for 62% of the variance; the eigenvalues of the remaining dimensions form a "scree-slope", indicating uninterpretable noise.

The first dimension distinguishes the events in our videoclip set that are reversible (roughly the "opening" events, shown in italics in the Appendix) from the events that are not reversible (roughly the "cutting and breaking" events, shown in normal font in the Appendix). Thus, children's errors notwithstanding, "reversible" versus "nonreversible" turns out to be a fundamental linguistic distinction in this domain. Clips depicting events of "peeling" and "taking apart" are not positioned close to either the "opening" or "cutting and breaking" clusters, although the two "peeling" clips are closer to the "cutting and breaking" cluster than to the "opening" cluster. This first dimension accounted for 21% of the variance.

The second dimension distinguished only one event from all the others – pushing a chair away from a table (also a reversible event). The third dimension distinguished the peeling events from all the other events. Thus, within the first three dimensions our core "cutting and breaking" events were distinguished from all the other separation events, revealing that across languages, events of material destruction form a semantic set that is distinct from other events of separation.

Because our main interest is in the semantic categorization of "cutting and breaking" events themselves, we carried out a second correspondence analysis on just the core set of "cutting and breaking" events revealed by the first correspondence analysis; i.e., we excluded the reversible separations, as well as the four "cutting and breaking" events that did not involve an agent.[6] The first four dimensions of this second analysis are the most important in understanding the similarity space of "cutting and breaking" events, as shown in Fig. 3; they account for 47% of the variance.

The first and most important dimension is Dimension 1. The positioning of the clips along this dimension is shown in Fig. 4 (the horizontal axis), plotted against Dimension 3 (the vertical axis). Dimension 1 is a continuous dimension that is not adequately captured by any single feature. For example, a clip's placement along the dimension does not reflect whether or not the agent used a tool to effect the separation, since events involving tools are spread along the whole dimension, and events involving the use of hands alone are positioned both in the middle of the dimension (e.g., "tearing" events, "karate-chopping"

[6] In separate analyses we have shown that these events are positioned in space close to their agentive counterparts – in other words, the same verbs are typically used regardless of whether the event is depicted as spontaneous or caused.

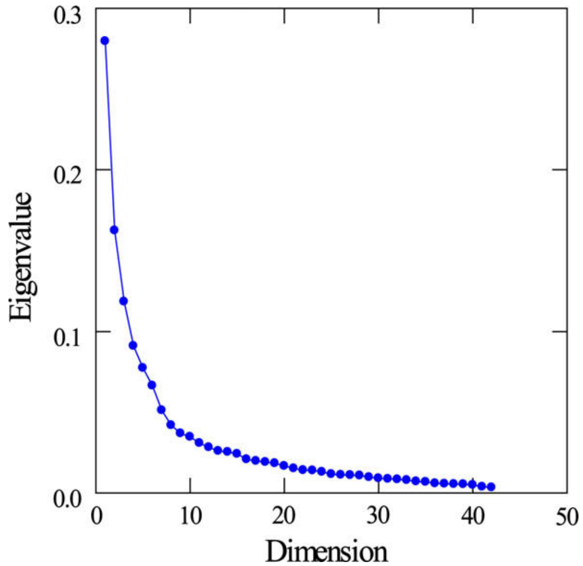

Fig. 3. Eigenvalues for correspondence analysis of ‘‘cutting and breaking’’ videoclips.

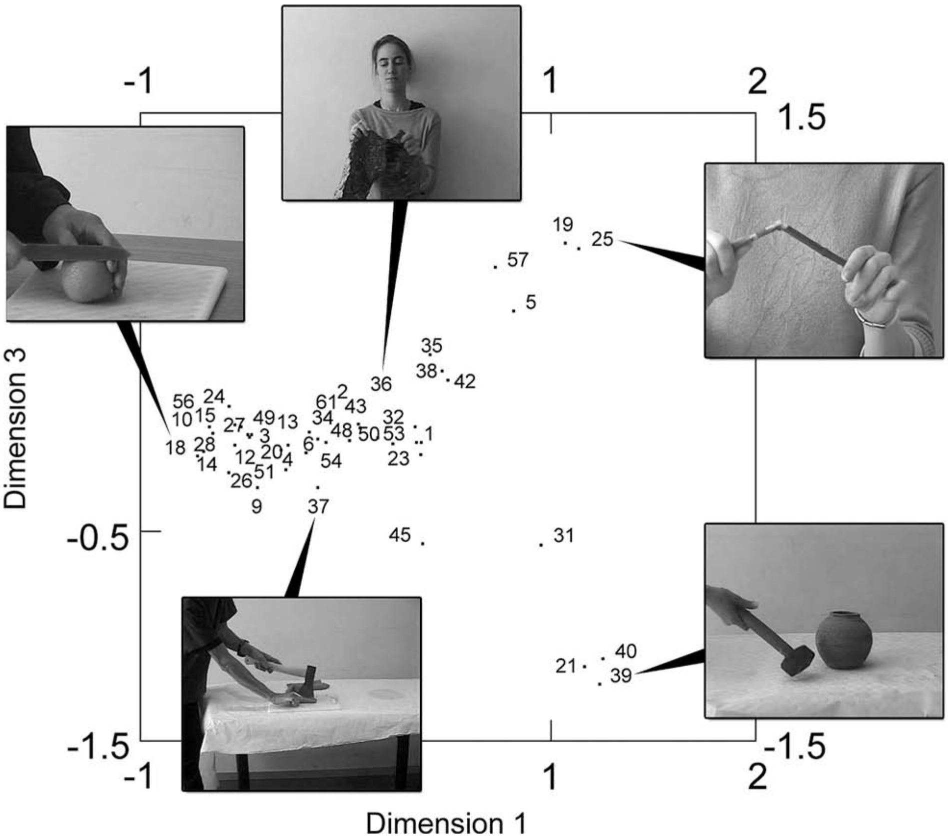

Fig. 4. Plot of Dimensions 1 and 3 of correspondence analysis of ‘‘cutting and breaking’’ verbs.

events) and at the end (e.g., ‘‘snapping’’). Placement also cannot be explained solely by the characteristics of the objects acted on, since the same objects are distributed across the plot. For instance, events involving the destruction of rigid objects (e.g., carrots, pots, plates) span the entire dimension; note the use of carrots in clips 10, 9, 6, 37, 54, 43, 32 and 21.

What is it then that accounts for the positioning of clips along this dimension – i.e., what does the dimension represent? Close inspection suggests that the dimension captures a relatively abstract notion: the *predictability of the locus of separation* in the affected object. Events with relatively high predictability, such as slicing a carrot with a knife (clip 10), are represented on the left. In these events the location of separation can be predicted very accurately, 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 positioned on the right. In these events, the locus of separation can only be guessed at: when the agent exerts force on the ends of the stick the stick will break somewhere between her hands, but we don't know where, and there may even be multiple fractures. Events intermediate in predictability fall between these extremes: for example, when a carrot is karate-chopped (clip 32), the carrot will separate wherever the edge of the hand falls, but for this ballistic action the point of contact between the hand and the carrot can be predicted only roughly.[7]

Gauging predictability in the locus of separation requires attention not only to the features of a separation event, but also to how these features play off against each other. For example, a blow by a hammer leads to a more predictable locus of separation if the object is a rope (clip 50) than if it is a pot (clip 39), since the rope will separate in only one place, where the hammer falls, but the pot will disintegrate into many pieces. In general, however, we are more likely to see knives and scissors as 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] For instance, it is easier to predict the point of separation when we cut a carrot with a knife (clip 10) than when we cut it with the blow of an axe (clip 37), because we have more control over the placement of the blade, and the consequent separation.

Events intermediate on Dimension 1 are treated variably across languages. Some languages group them with "precise control" events, positioned to the left, while other languages group them with "imprecise control" events, positioned to the right. Still other languages assign 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 *tek'e-* 'cut/break' for both, but a different verb, *tyof'* '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' and using a different verb, *kaaT* 'cut', for the carrot-cutting clip. The third pattern is exemplified by Jalonke (a Niger-Congo language of Guinea), whose speakers give distinct encoding to all three clips: *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, the two clips that 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 applied *only* to these videoclips.[9] The remaining languages grouped these clips variably with other clips. In a common pattern (e.g., Sranan, Tiriyó, Yukatek), the verb used for the tearing clips was also applied to clips depicting the separation of cloth with a hammer (clip 23) or a karate chop (clip 34). 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). In still another pattern (Otomi), the same verb was used for all separations involving cloth and yarn, as well as rope, regardless of how these separations were brought about. Thus, tearing fell together with separations effected by scissors, knife or chisel, as long as the object was cloth or rope (clips 2, 49, 50 and 61).

Further patterns seem more unusual to speakers of English. For example, in Miraña (a Witotoan language spoken in Colombia) the same verb was used not only for the "tearing" events (clips 1 and 36) but also for five additional clips that all involved destruction with a sharp blow (e.g., chopping cloth with a hammer, clip 23; splitting a melon with a sharp blow of a machete, clip 51; smashing a plate with a hammer, clip 40). In Yélî Dnye (a language isolate of Papua New Guinea), the verb used for the two "tearing" events was also used for carrot-cutting events (clips 37, 9) that depict an object being separated along the grain – as is also true of the tearing events.

Dimension 3 makes a further distinction among the events already distinguished along Dimension 1 as low in the predictability of the location of separation (i.e., events to the right in Fig. 4): it differentiates between events of "snapping" and "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 a blow, e.g., with a hammer (clips 40, 39, 21, 31; see Fig. 4). As with Dimensions 1 and 2, the exact distinctions made along Dimension 3 vary across 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*. English speakers made this distinction optionally: some distinguished the clips with the verbs *snap* versus *smash*, while others grouped them together as instances of *break*.

[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. But here we emphasize predictability rather than control because the verbs associated with a particular region of Dimension 1 can be used even when the agent acts unintentionally (e.g., accidentally cutting a finger, videoclip 18).

[8] We stress that it is not bladed versus blunt instruments per se that is crucial, since predictable separation can also be brought about bladelessly, e.g., by laser technology, and a bladed instrument can be applied noncanonically to bring about an unpredictable separation – think of breaking an egg by tapping it with a knife.

[9] In our stimulus set "tearing" was exemplified only by actions on cloth, but it is likely that "tearing" verbs are – as in English and other well-known languages – often applied to a wider range of events involving flat, flexible materials, such as plastic bags or paper.

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

Language	Dimension				Mean (SD)
	1	2	3	4	
	"Predictability"	"Tear"	"Snap-smash"	"Poke a hole"	
Biak	.90	.75	.89	.81	.84 (.07)
Chontal	.81	.92	−.04	.19	.47 (.47)
Dutch	.78	.88	.64	.55	.71 (.15)
English	.93	.93	.48	.63	.74 (.23)
Ewe	.80	.70	.89	.70	.77 (.09)
German	.82	.77	.77	.51	.72 (.14)
Hindi	.89	.57	.20	.59	.56 (.28)
Jalonke	.88	.81	.87	.83	.85 (.03)
Japanese	.60	.90	.53	.81	.71 (.17)
Kilivila	.94	.71	.95	.91	.88 (.11)
Kuuk Thaayorre	.93	.95	.76	.89	.88 (.09)
Lao	.60	.53	.73	.48	.59 (.11)
Likpe	.77	.45	.85	.78	.71 (.18)
Mandarin	.79	.75	.79	.81	.79 (.03)
Miranya	.83	.67	.57	.15	.56 (.29)
Otomi	.93	.68	.91	.66	.80 (.14)
Punjabi	.86	.94	.08	.21	.52 (.44)
Spanish	.79	.61	.60	.36	.59 (.18)
Sranan	.85	.95	.04	.74	.65 (.41)
Swedish	.89	.91	.70	.73	.81 (.11)
Tamil	.82	.92	.19	.62	.64 (.32)
Tidore	.75	.94	.82	.81	.83 (.08)
Tiriyó	.83	.97	.88	.74	.86 (.10)
Touo	.83	.87	.70	.50	.73 (.17)
Turkish	.88	.62	.43	.14	.52 (.31)
Tzeltal	.84	.88	.89	.74	.84 (.07)
Yélî Dnye	.81	.62	.20	.68	.58 (.26)
Yukatek	.93	.83	.90	.81	.87 (.06)
Mean	.83	.79	.62	.62	
SD	.09	.15	.30	.23	
Minimum	.60	.45	−.04	.14	
Maximum	.94	.97	.95	.91	

Dimension 4 distinguished only one scene from the others – poking a hole in a piece of cloth stretched tautly between two tables (clip 45). In some languages there was a verb which was used only for this clip (e.g., Ewe, Japanese, Jalonke, Kilivila, Likpe, Mandarin), whereas in other languages the verb applied to this clip was used for other clips as well. In English, for example, the verbs *stab* and *bodge* were used for this clip and for clip 43, in which a person divides a carrot in two using a chisel. This pattern is also found in Kuuk Thaayorre. Still other languages, including Dutch, German and Punjabi, did not distinguish clip 45 at all. Dutch speakers, for example, lumped clip 45 under the verb *hakken* 'chop' along with clips 2, 3, 4, 6, and 12.

To summarize, languages treat "cutting and breaking" events differently from other types of separation events: the verbs applied to actions of cutting and breaking are not used for events like peeling, opening and taking apart. This finding was not obvious a priori. Recall that children often overextend verbs across the boundary between reversible and nonreversible separations, which suggests that what these events have in common – separation – is cognitively salient, and so might have been captured by the verbs of some languages.

Within the set of "cutting and breaking" events there are recurrent patterns of categorization, and the distinctions that languages make can be captured by a small number of dimensions. These dimensions account for about half of the variance in this dataset. The first and most important dimension is a continuous one that distinguishes among 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 discrimination among the set of events where the location of separation is unpredictable, distinguishing "snapping" events from "smashing" events. Finally, the fourth dimension distinguishes "poking a hole" in a piece of cloth from other scenes.

Although the precise categories recognized by the languages in our sample differ, they are highly constrained by the four dimensions we have described. These dimensions delineate a semantic space in which the categories recognized by individual languages, as variable as they are, encompass adjacent clips.

3.1.1. A general solution, or averaging?

But before accepting the conclusion that the semantic space of cutting and breaking is highly constrained, as we have suggested, it is important to rule out a possible alternative. Perhaps languages actually vary radically, and the dimensions we have discussed are merely statistical averages that do not reflect the structure of individual languages. To address this possibility we correlated the dimensions extracted by the general solution with the dimensions extracted for each language individually, as shown in Table 2. If the language-general dimensions reflect only statistical averaging, and languages in fact categorize strikingly differently, these correlations should be low. But if these dimensions reflect patterns of categorization that are widely shared across languages, the solutions extracted for the individual languages should correlate highly with them.

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 dimensions are extracted in order according to how much of the variance (from higher to lower) they account for. In line with this logic, the distinctions captured by earlier-extracted dimensions are honored in more languages than those captured by 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.

Speakers of the languages that correlate highest with Dimension 3, such as Kilivila, Otomi and Biak, always used distinct verbs for "snapping" versus "smashing" events. 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 at all, and use instead a general "break" verb (Hindi, Punjabi, Tamil, Yélî Dnye and Sranan), or they make a cross-cutting distinction. The latter is the case for Chontal, which has the lowest correlation on Dimension 3. It lacks distinct "snapping" and "smashing" verbs, collapsing the distinction with the verb *pay*, a general "break" verb. A cross-cutting distinction is made by the verb *tjof'*, which is also used for the "snapping" events as well as for "non-snapping" separations of one-dimensional objects, such as cutting ropes and twigs.

Overall, the 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.

3.1.2. *Further evidence for a general solution*

In the previous section, we showed that individual languages correlate well with the four dimensions extracted by the correspondence analysis, but these four dimensions capture only about half of the variance in the overall dataset. Perhaps, then, we have exaggerated the consistency across languages by disregarding the remaining data. In order to capture how similar languages are in their *overall* categorization patterns, we used the factor-analytic methods described by Romney, Weller, and Batchelder (1986). In this technique, the similarity matrices of individuals – or, in our case, languages – can be compared in their entirety, and a measure of agreement extracted.

To conduct the analysis, we correlated the videoclip-by-videoclip similarity matrices of the 28 languages with each

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
SD	0.14	0.15	0.15
Minimum	0.09	0.04	0.04
Maximum	0.71	0.72	0.71

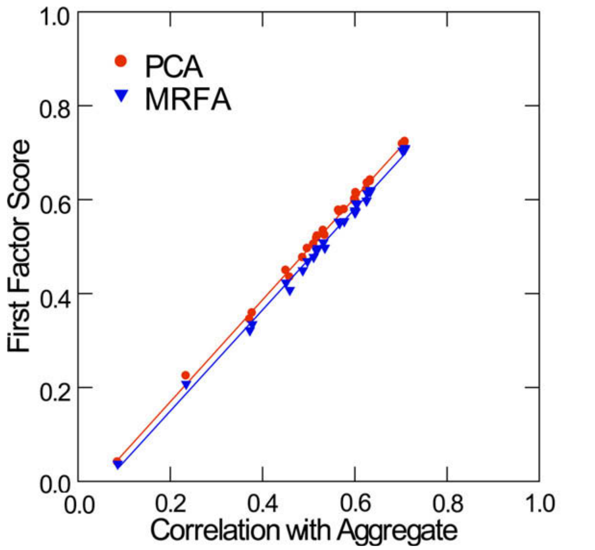

Fig. 5. Correlation of first factor scores and the aggregate for individual languages in PCA and MRFA.

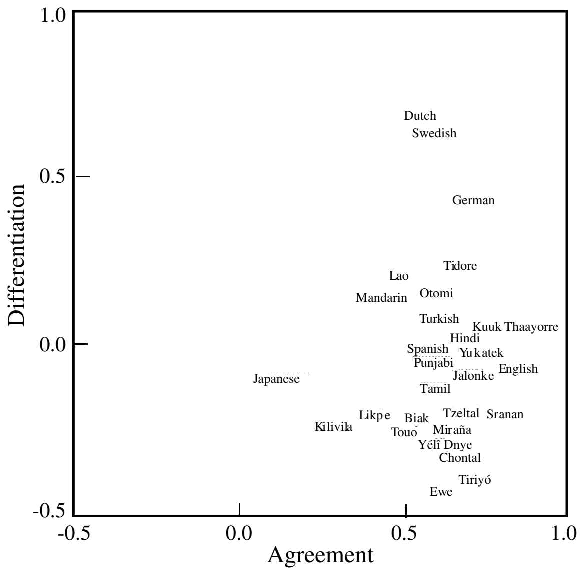

Fig. 6. Factors 1 and 2 from the PCA model: Agreement and differentiation among languages in their overall classification of "cutting and breaking" events.

other and factor-analyzed the resulting correlation matrix, using both principal components analysis (PCA) and minimal residual factor analysis (MRFA). If languages categorize events very similarly, they will correlate positively with each other, so factor scores on the first factor will also be positive. Languages that do not share a particular pattern of categorization will correlate negatively with languages that do, so they will load negatively on the first factor. The strength of the agreement between languages can be assessed by the size of the eigenvalues (see Boster & Johnson, 1989).

Overall correlations are given in Table 3. The two factor-analytic methods (PCA and MRFA) gave essentially identical results, as indicated in Fig. 5, so we restrict our discussion to the PCA model.

Fig. 6 shows a plot of the first two factors. Each language is plotted in the figure on the basis of how similar it is to the other languages in its overall similarity matrix, i.e., its overall pattern of categorizing the "cutting and breaking" videoclips. The more similar two languages are in their classification, the closer together they are plotted in space. The first factor taps common structure across languages. This can be interpreted as an "agreement" dimension – if languages agree with one another in how they categorize these clips, 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. Languages plotted far apart from each other on this dimension are different from each other in some aspect of their categorization.

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 shows that the low agreement for these languages does not come about because they categorize strikingly differently from the other languages, but because their data matrices are sparse. For both languages the data came from only one participant, and there were missing responses for some of the events. In addition, the Japanese and Kilivila speakers used a larger number of verbs unique to a single videoclip than did speakers of other languages. This means that relatively few of the clips fell into the same category. Further research is necessary to determine whether the anomaly of these two languages would persist if the languages were better sampled.

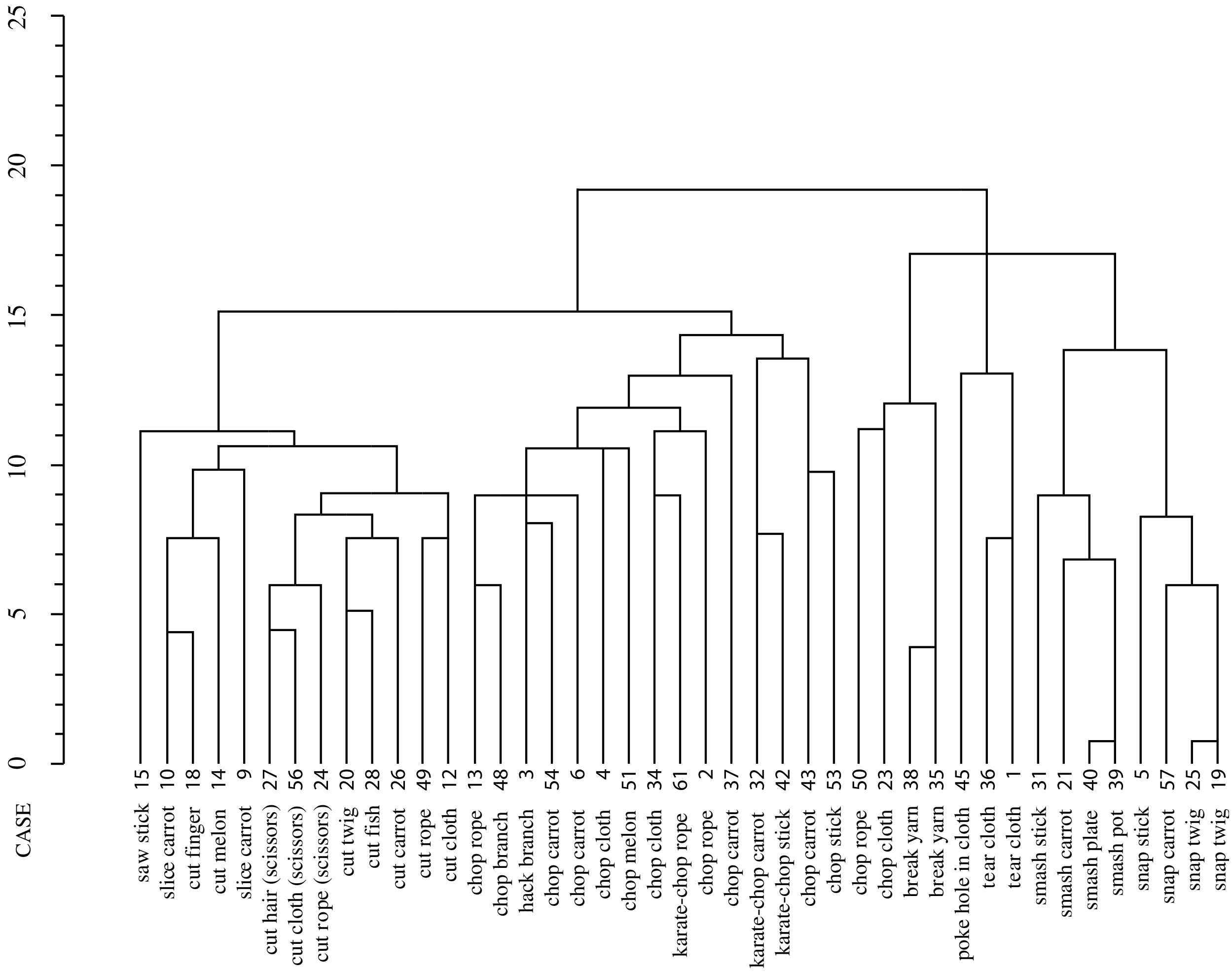

Fig. 7. Dendogram of cluster analysis based on the semantic categorization of "cutting and breaking" events in all the languages.

The second criterion 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.

3.2. Most common category groupings

We have shown that languages agree with one another in how they categorize events of "cutting and breaking", in the sense that there is a common set of semantic dimensions underlying this categorization. But even while respecting the dimensions, languages could still have myriad different ways to carve up the semantic space that they delineate. This raises the question whether some categorization patterns 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. Fig. 7 shows the main clusters across languages. Note that this is a "winner-takes-all" plot: clusters are defined by the groupings that are most common across languages, so each individual language's way of grouping is not faithfully depicted.

The dendogram in Fig. 7 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 pivots at the top while maintaining their structure. We have rotated the clusters in order to mirror, as closely as possible, the order of the videoclips in Dimension 1 of the correspondence analysis – highly predictable events to the left of the figure, poorly predictable events to the right. The analysis uncovers two major clusters, corresponding roughly to "cutting" events – higher in predictability – and "breaking" events – lower in predictability. Most languages group events of intermediate predictability, such as karate-chopping a carrot, with the "cutting" events. Thus, the Chontal strategy, discussed earlier, of grouping karate-chopping events with fine-precision actions of cutting is more common cross-linguistically than the Hindi strategy of grouping these events with the breaking events.

Also noteworthy in the "cutting" cluster is the subgroup of events of cutting with scissors. A few languages in our sample, such as Dutch, Swedish and Mandarin, make an obligatory distinction between cutting with a single blade (e.g., a knife, piece of glass or wire) and cutting with a double blade (e.g., scissors, nail clippers). This distinction did not show up as a dimension in our correspondence analysis because most of the languages do not differentiate these events with distinct verbs, but its influence is visible here in the cluster analysis.

Within the "breaking" cluster, there are three major subclusters. The right-most cluster includes both "snapping" events and "smashing" events. These events are distinguished on Dimension 3 of the correspondence analysis, and this distinction is respected by most languages, but enough languages routinely apply the same verbs to events of both subtypes that there is a cluster encompassing both. The next major subcluster includes both of the "tearing" events (distinguished on Dimension 2 of the correspondence analysis) as well as the event of "poking a hole in fabric" (distinguished on Dimension 4). These do not fall out as separate clusters at the highest level because many languages do not have dedicated verbs for such events. The last subcluster includes "pulling apart yarn" and some of the "chopping" events. Although most of the "chopping" events are grouped with the "cutting" events, a few are pulled into this cluster because they involve a separation in a flexible object. As discussed earlier, some languages (e.g., Sranan) use their "tearing" verb for separating flexible materials with a blow. As a consequence, some "chopping" events involving flexible objects are in the same superordinate cluster as (although in a distinct subordinate cluster from) the "tearing" events.

4. Discussion

Speakers of typologically, genetically and geographically diverse languages show considerable agreement in how they implicitly categorize events of "cutting and breaking" through the verbs they use to describe them. First, they agree on treating such events as a relatively coherent semantic domain. At the beginning of this investigation it was unclear whether there is such a thing as a core semantic domain of "cutting and breaking" events – i.e., whether languages routinely distinguish these kinds of events as a group from other kinds of separations. (Recall that children often overextend verbs like *break* to reversible events like opening a safety pin and *open* to irreversible events like breaking the leg off a doll [Bowerman, 2005; Schaefer, 1979], which suggests that the property of [ir]reversibility is not necessarily definitive in the human cognition of separation events.) But the adult speakers of the languages in our sample respected this boundary. On the one hand, they rarely described reversible separations like taking the lid off a teapot or pulling paper cups apart with the same verbs they used for irreversible separations like breaking a plate or cutting a rope. On the other hand, they often used the same verbs for a variety of actions involving cutting and breaking. "Cutting and breaking" events were treated as far more similar to each other than they were to the other kinds of separations.

As a second point of convergence, speakers of different languages agreed substantially in the dimensions along which they implicitly grouped or discriminated core events of cutting and breaking. This was true even though our consultants ranged from industrial urban-dwellers to rainforest-dwelling swidden agriculturists, and they used different tools and techniques for cutting and breaking. Speakers of Yélî Dnye provide a good example. These people 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. Before this there were no sharp instruments; the island is basalt and there was no stone suitable for making cutting tools. Despite this difference in cultural ecology, Yélî Dnye still correlates extremely well with the pattern of categorization found in the other languages in our sample (see Table 2; cf. Levinson, 2007).

The linguistic categorization of the "cutting and breaking" domain cannot be captured by reference to one or a few simple features, such as the instrument or the manner of separation; more abstract constellations of features are at stake. The most important of these is the predictability of the locus of separation in the affected object. Events in which the locus of separation is highly predictable (roughly, "cutting" events) are distinguished from events in which it is not very predictable (roughly, "breaking" events) (see Dimension 1 in Fig. 4). Among events with intermediate predictability, "tearing" events were often further distinguished (Dimension 2), while among events with low predictability, "snapping" and "smashing" events were often described differently (see Dimension 3). Finally, within our set of "cutting and breaking" events, poking a hole in a cloth with a twig was often honored with a unique verb (Dimension 4). The multidimensional space defined by these four dimensions is not an artifact of statistical averaging over radically different languages; all the languages of our sample correlate well with the common solution.

The shared semantic structure in our data challenges some widespread assumptions about the kind of categorization imposed by words belonging to different parts of speech. Some researchers have made a fundamental distinction between open-class items (e.g., nouns, verbs, adjectives) and closed-class items (e.g., prepositions, conjunctions, articles, inflections), arguing that universality is to be sought in the meanings of closed-class items (e.g., Bickerton, 1981; Pinker, 1984; Slobin, 1985; Talmy, 1985, 1988). By hypothesis, these forms are heavily constrained in their distinctions, whereas open-class items can mean just about anything. Another proposal puts a critical cut not between open-class and closed-class items, but between verbs and nouns. Verbs are held to have more variable meanings than nouns, especially across languages (e.g., Gentner, 1981, 1982; Gentner & Boroditsky, 2001; Huttenlocher & Lui, 1979; Morris & Murphy, 1990). If the meanings of open-class items in general, or of verbs in particular, are indeed relatively free to vary, there is no reason to expect cross-linguistic commonality in the categorization of events of "cutting and breaking". But the categorization is in fact strongly constrained, as our study shows. This suggests that there is more regularity in the event categories defined by verbs than has often been supposed.

Up to this point in the discussion we have emphasized cross-linguistic similarities; now let us turn to differences. Although the *dimensions* of categorization in the domain of "cutting and breaking" are shared across languages, the precise *categories* languages recognize vary widely. For example, Tzeltal speakers from the Highlands of Mexico described the "cutting and breaking" videoclips using more than 50 different verbs, each with highly specific semantics (P. Brown, 2007). Yélî Dnye speakers, in contrast, used only three different verbs, each encompassing many different sorts of events (Levinson, 2007). Speakers of most languages used the same verbs for cutting with scissors as cutting with a knife (both *cut*, in English), but a few languages, including Dutch, Swedish, and Mandarin, obligatorily distinguished cutting events according to whether the tool had a single or a double blade. Speakers of Chontal described "chopping" events with the same verb as they used for "cutting" events involving predictable separation, while Hindi speakers lumped chopping events together with "breaking" events involving non-predictable separation. And so on. Despite shared parameters of meaning, then, the actual event categories in the domain of "cutting and breaking" are variable.

Where do these discrete categories come from? One view has been that the categories humans recognize are based on observation of correlations in the distribution of features in the environment (Rogers & McClelland, 2004; Rosch, Mervis, Gray, Johnson, & Boyes-Braem, 1976). For example, "has beak", "has wings" and "lays eggs" are features that covary to delineate the category of birds; "has roots", "has rigid cell walls" and "can grow tall" covary for the category of plants. If human cognizers are sensitive to inter- and intra-category feature correlations, they can construct categories on the basis of coherent covariation of features.

Features of real-world events such as cutting and breaking also show coherent covariation. A locus of a separation is highly predictable if it is caused by pressure from a sharp instrument on an object that is firm but yielding – neither too rigid (e.g., a plate) nor too fluid (e.g., an egg yolk). A certain manner of action is also implicated: the sharp instrument must start out in close proximity to the to-be-separated object, rather than being swung against it ballistically as, for example, in chopping. This combination of instrument, object and manner leads to a predictable result: a separation with two smooth, clean edges (as opposed to the ragged edges resulting from "tearing", "snapping" or "smashing"). But even though the features of "cutting and breaking" events co-vary, the events do not fall into coherent clusters recognized by all languages. Recall, for example, that the most important dimension in our correspondence analysis – the predictability of locus of separation – is continuous, not categorical (Fig. 4). It seems to be the linguistic system itself that provides the discrete categories; the environment only offers the dimensions taken to be relevant.

Of course, not everyone agrees that such a central role should be given to language in accounting for where some of our semantic categories come from. An alternative view is that infants are sensitive to the "conceptual distinctions that are central to the semantics of any human language" (Hespos & Spelke, 2004, p. 453) – in other words, that babies come equipped with the full repertoire of conceptual categories coded in languages. These categories can be maintained, weakened or enhanced through subsequent linguistic experience, but they do not arise in the first place through exposure to language.

This view is plausible only to the extent that the precise categories encoded across languages form a limited set (see also Bloom, 2000, p. 253). The more the precise make-up of categories varies across languages, with cross-cutting sets of elements falling together in some languages and apart in others in a kaleidoscope of recombinations, the less likely it is that children are born with all the potential categories, and the more likely it is that they can construct them on the basis of relevant input. In our view, the number and content of "cutting and breaking" categories are too diverse across languages for it to be plausible that they are all available prior to language; it is more likely that they are learned with the help of the linguistic input. There is in fact increasing evidence that toddlers can draw on linguistic input to construct semantic categories of events (e.g., Bowerman, 2005; Bowerman & Choi, 2001; Casasola, Wilbourn, & Yang, 2006).

At the same time, the learning probably does not begin from scratch. As our study shows, there are strong constraints on the categorization of cutting and breaking events: the main parameters of variation can be captured in only a few dimensions. These dimensions are likely to be important in human event cognition, and to exert an influence not only on the structure of adult languages but also on how children go about learning verbs like *cut* and *break*. So although learners must figure out how many categories there are and the locations of the boundaries between them, they may receive a boost from knowing ahead of time what kinds of similarities and differences among events could make a difference.

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Appendix. Below are short descriptions of the video stimuli used in this study, which were designed by Bohnemeyer et al. (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 chisel blow.
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 crosswise intensely with big knife.
7. *Push chair back from table*.
8. **Piece of cloth tears spontaneously into two pieces**.
9. Slice carrot lengthwise into two pieces with knife.
10. Slice carrot crosswise 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 with knife.
13. Cut rope stretched between two tables with axe blow.
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 blows.
22. **Take top off pen**.
23. Chop cloth stretched between two tables into two pieces with two hammer blows.
24. Cut rope in two with scissors.
25. Snap twig with two hands, but it doesn't come apart.
26. Cut carrot crosswise into two pieces with a couple of sawing motions of 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 hammer blow.
32. Cut carrot in half crosswise with single karate chop.
33. *Open a book*.
34. Chop cloth stretched between two tables with single karate chop.
35. Break yarn into many pieces with intensity.
36. Tear cloth about halfway through with two hand.
37. Cut carrot in half lengthwise with single axe blow.
38. Break single piece off a length of yarn by hand.
39. Smash flower pot with single hammer blow.
40. Smash plate with single hammer blow.
41. *Open a hinged box*.
42. Break vertically-held stick with single karate chop.
43. Cut carrot crosswise into two pieces with single chisel blow.
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 hammer blows.
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 chisel blow.

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

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