

Negentropic causation vs. entropic inchoation

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This paper plumbs the fine semantic structure of causative-inchoative verbs such as *break* and *melt* to uncover a bipartite structure in which a negentropic action chain is followed by an entropic action chain. Under highly specific conditions, these two chains can be lexicalized as a single verb; otherwise, they are lexicalized by a periphrastic construction. The bipartite structure is highly reminiscent of the decomposition of causative verbs into abstract predicates such as [CAUSE [BECOME broken]], and can be considered a first approximation to a cognitive definition of these predicates.

I. Introduction to the data

Talmy (1996:252) claims that the English *by-* phrase can only refer felicitously to the penultimate subevent of a causative clause like *Mary broke the window*:

1. Mary broke the window...
 - a) * ... by grasping a stone in her hand.
 - b) * ... by lifting a stone with her hand.
 - c) * ... by swinging a stone with her arm.
 - d) * ... by propelling a stone through the air.
 - e) * ... by throwing a stone towards it.
 - f) ? ... by throwing a stone at it.
 - g) by hitting it with a stone.

Ungerer & Schmid (1996:231) think that this is a significant enough generalization to repeat (1) in their introduction to *Cognitive Linguistics*. Unfortunately, it is incorrect. It is not difficult to find causatives for which the *by-* phrase does not pick out the penultimate subevent of a causative event.

As a first example, consider a simple restatement of (1) that more accurately reflects all of the events in the action chain, as in (2):

2. Mary broke the window
 - a) Mary grasped a stone in her hand.
 - b) She lifted it with her hand.
 - c) She swung her arm.
 - d) She released the stone.
 - e) The stone flew through the air.
 - f) It hit the window.
 - g) The window broke.

The last subevent whose Agent was Mary is (2d), but it does not license a *by* phrase, as seen in (3):

3. * Mary broke the window by releasing a stone.

Indeed, the action chain of (2) would best seem to license the *by* phrase of (1f), vid. (4):

4. Mary broke the window (by throwing a stone at it)
 - a) Mary grasped a stone in her hand.
 - b) She lifted it with her hand.
 - c) She swung her arm.
 - d) She released the stone.
 - d') [All of this constitutes an event of Mary throwing a stone]
 - e) The stone flew through the air.

- f) It hit the window.
- g) The window broke.

To my ear, the *by* phrase of (1g) preferentially expresses the action chain of (5):

- 5. Mary broke the window (by hitting it with a stone)
 - a) Mary grasped a stone in her hand.
 - b) She lifted it with her hand.
 - c) She struck it against the window.
 - d) The window broke.

Be that as it may, the revised form of (4) is a clear counterexample to Talmy's claim.

Moreover, a small change in the usage of *break* leads to an even greater gap between the link that licenses the *by* phrase and the penultimate one:

- 6. I broke the vase (by accidentally knocking it off the shelf while I was cleaning)
 - a) I was cleaning the room.
 - b) I accidentally hit the vase on its shelf.
 - c) The vase fell from the shelf.
 - d) It fell all the way down to the floor.
 - f) It hit the floor.
 - g) It broke.

The rest of this section demonstrates that the verb *break* is not an isolated case, but rather is representative of a general class of counterexamples.

Consider the action chain for the first clause in (7):

- 7. I did in my neighbor's vicious dog
 - a) I got some rat poison.
 - b) I took it with me.
 - c) I put it in the dog's food.
 - d) The dog came up to its poisoned food.
 - e) It ate it.
 - f) The poison diffused into the dog's body.
 - g) It damaged vital organs in the dog's body.
 - h) The dog died.

Only (6c) licenses a *by*- phrase, as seen in (8):

- 8) I did in my neighbor's vicious dog by putting rat poison in its food.

Before jumping to conclusions, let us examine two more events of poisoning and their action chains:

- 9. I accidentally killed the goldfish in my pond (by pouring tap water into it)
 - a) I picked up the garden hose.
 - b) I turned on the faucet that the hose was attached to.
 - c) I poured the water that came out into my pond.
 - d) Chlorine in the tap water diffused into the pond water.
 - e) The chlorine entered my goldfish's gills.
 - f) It damaged their gills.
 - g) They lost the ability to take in oxygen.
 - h) They died.

- 10. I got rid of the roaches (by sprinkling insecticide all around the basement)
 - a) I got some insecticide.
 - b) I took it into the basement.
 - c) I sprinkled it all around the basement.
 - d) The roaches came out of hiding.
 - e) They were attracted to the insecticide.

- f) They ingested it.
- g) It damaged their vital organs.
- h) They died.

Clearly, the *by-* phrases do not relate the subevent immediately preceding the death of the organisms in question, which would be (9f, 10g). What they do relate is the last subevent in which I manipulate the poison, but after that, the poison is relayed to the victims by means which do not involve my physical contact or input of energy.

Such situations of poisoning are in no way exceptional. Consider the examples in (11), which are drawn from the class of causative-inchoative verbs, and the action chains that could be postulated for them in (12) to (15):

- 11
- a) I melted some butter by putting it in a hot frying pan.
 - b) I accidentally froze a beer by putting it in the freezer instead of the refrigerator.
 - c) Terrorists could flood the Grand Canyon by blowing up the Glen Canyon Dam.
 - d) An iceberg sank the Titanic by ramming into it.

12. I melted some butter (by putting it in a hot frying pan)
- a) I picked up some butter.
 - b) I dropped it into a hot frying pan.
 - c) The heat from the frying pan diffused into the butter.
 - d) The butter melted.

13. I accidentally froze a beer (by putting it in the freezer instead of the refrigerator)
- a) I picked up a beer.
 - b) I put it into the freezer [instead of the refrigerator].
 - c) All of the heat of the beer diffused out into the freezer.
 - d) The beer froze.

14. Terrorists flooded the Grand Canyon (by blowing up the Glen Canyon Dam)
- a) Terrorists planted explosives at weak points along the Glen Canyon Dam.
 - b) The explosives exploded.
 - c) The Glen Canyon Dam collapsed.
 - d) Water held back by the dam flowed into the Grand Canyon.
 - e) It gathered there and rose.
 - f) The Grand Canyon flooded.

15. An iceberg sank the Titanic (by ramming into it)
- a) An iceberg rammed into the Titanic.
 - b) The hull of the Titanic ripped open.
 - c) Water flooded into the hull.
 - d) It filled the hull.
 - e) The weight of the water overcame the buoyancy of the ship.
 - g) It sank.

While in (12) and (13), the clauses that license the *by-* phrases are only one link removed from the penultimate subevent, in (14) and (15) the clauses that license the *by-* phrases are several links removed.

These action chains are taken from the domain of what can be called common-sense physics, but the domain of tightly-structured human organizations also shows instances of non-penultimate *by* sources. Consider the examples in (16) and their corresponding action chains in (17) and (18):

16. Terrorists could ...
- a) ... paralyze the economy by blowing up the World Trade Center.
 - b) ... devalue the dollar by blowing up Fort Knox.

17. Terrorists could paralyze the economy (by blowing up the World Trade Center)
- Terrorists could plant explosives at weak points along the World Trade Center.
 - The explosives would explode.
 - The force of the explosion would blow up the World Trade Center.
 - Economic transactions in New York would be disrupted.
 - Economic transactions across the country would be disrupted.
 - The economy would be paralyzed.
18. Terrorists could devalue the dollar (by blowing up Fort Knox)
- Terrorists could plant explosives at weak points along Fort Knox.
 - The explosives would explode.
 - The force of the explosion would blow up Fort Knox.
 - All of the gold in Fort Know would be destroyed.
 - The material basis of the dollar would destroyed.
 - The dollar would be devalued.

While it is impossible to check the presumably infinite number of *by* phrases for their adherence to Talmy's hypothesis, the small survey undertaken above indicates that there are enough counterexamples to look for an alternative.

II. Initial description of the data

The action chains adduced above have two obvious parts, which are separated by the underline. The first part consists of those links in which the subject of the clause initiates or completely performs some action. The second part consists of those links in which the object of clause responds to the action in such a way that it undergoes a change of state at the very end.

This description is clearly reminiscent of a long line of inquiry in modern linguistics about the relations between stative, inchoative, and causative clauses. Much of it begins with Lakoff's (1970[1965]) proposal that the similarity in meaning between (19a) and (19b) can be accounted for by positing that at some level of analysis they share the structure of (19c):

- 19
- John hardened the metal.
 - John caused the metal to harden.
 - (John CAUSE (the metal BECOME hardened))

Lakoff extends this decompositional strategy to account for the similarities between the adjectives and deadjectival inchoative verbs in (20):

- 20
- | | | | |
|----|---------------------|---------------------|----------|
| a) | The metal is hard. | The metal hardened. | (5-7, 1) |
| b) | The liquid is cool. | The liquid cooled. | (5-7, 2) |

Lakoff postulates a five-step process of inchoativization which changes a structure paraphrasable as "that the metal is hard came about" into the surface structure with the deadjectival verb, e.g. "the metal hardened." Inchoativization serves as the input to causativization simply by embedding the inchoative phrase under the causative verb with its subject, as exemplified in (21c) below. Lakoff is thus able to unify transformationally the following three kinds of clauses:

- 21
- Stative:
[the metal be hard] => The metal is hard.
 - Inchoative:
[that [the metal be hard] come about] => The metal hardened.
 - Causative:
John bring about [that [the metal be hard] come about] => John hardened the metal.

This proposal was extremely controversial, as is discussed below.

For our purposes, what is important is that the causatives in (19) can be understood to abbreviate a longer action chain, such as that of (22):

22. John hardened the metal (by dipping it in a special solution)

- a) John grasped the (piece of) metal in his hand.
- b) He lifted it.
- c) He lowered it into a container of special solution.
- d) The metal made contact with the solution.
- e) A physical change propagated through it.
- f) It hardened.

The exact contribution of the stative does not appear to be relevant to the *by* phrase and so will be ignored. Let us use Lakoff's terminology to label the two halves of this action chain as in Table 1:

Table 1. Causative-inchoative action chain for (19)

Causative:
John grasped the (piece of) metal in his hand
He lifted it
He lowered it into a container of special solution
Inchoative:
The metal made contact with the solution
A physical change propagated through it
It hardened

With this descriptive analysis, we can restate Talmy's hypothesis of the *by* phrase as in (23):

23. A *by* phrase clarifies the exact manner of causation performed by the Causer.

A deeper understanding of inchoation will enable us to be even more precise, for which we turn to an observation made by a different researcher on different data.

III. The -ya- present forms of Vedic Sanskrit and entropy

Kulikov (1998) finds that the -ya- present forms of Vedic Sanskrit can be grouped into the two notional sorts in (24) and (25):

24. Destruction

- | | |
|-------------|----------------------------|
| a) chidyate | is cut off, breaks |
| b) diryate | splits, breaks |
| c) bhidyate | splits, breaks |
| d) siryate | crushes, breaks, collapses |
| e) ksyate | wastes, disappears |
| f) miyate | is damaged, perishes |
| g) lupyate | tears, is omitted |

25. 'Destructuring'

- | | |
|------------|---|
| a) jiyate | suffers loss |
| b) mucyate | becomes free, is released [i.e. ceases to be bound or included in a bound system] |
| c) sisyate | is left over [i.e. becomes a remainder of a structure] |
| d) hiyate | is left over [i.e. becomes a remainder of a structure] |
| e) siyate | falls (out) [i.e. ceases to be included in a structure by falling out of it] |

The challenge is to reduce these two sorts to a common feature.

What Kulikov proposes is that both of them refer to the **increase of entropy**:

The concept of entropy was proposed in 1850 by R. Clausius, a German physicist, and is sometimes presented as the second law of thermodynamics. According to this law, entropy increases during irreversible processes such as the spontaneous mixing of hot and cold gases, the uncontrolled expansion of a gas into a vacuum, and the combustion of a fuel. Very soon the notion of entropy had been

extrapolated to many other domains, such as destruction or simplification of a system, death of a living being, etc.

All spontaneous processes of such kind are irreversible, hence it has been said that the entropy of the universe is increasing. That is, more and more energy becomes unavailable for conversion into mechanical work, and because of this the universe is said to be “running down”. According to the same law, everything in the universe is irrevocably moving in the direction of random chaos and waste.

Kulikov proposes that the notion of ‘spontaneous process’ that has been used so often to capture the essence of middle and inchoative or anticausative verbs is largely reducible to the notion of an entropic or entropy-increasing process. In particular, all these revolve around a natural source of energy, e.g. *heat, dry, shine, boil*, and *grow*, or a natural chemical process, such as burning of fuel, souring of milk, etc.

The -ya- present forms of Vedic Sanskrit are just one instantiation of such entropic processes:

Note that any event concerned with (spontaneous) falling down of an object leads to a decrease of energy of the object and, hence, to decrease of the total energy of the system consisting of this object and the source of gravitation (normally, the earth), which implies increase of entropy. Furthermore, the falling of an element out of a system simplifies the system, so that its total energy decreases while entropy increases.

Unfortunately, Kulikov does not pursue this idea into a larger survey of middle and inchoative or anticausative verbs.

IV. Entropy in action chains

Let us return to the data of this paper and in particular the action chain in (9), repeated here as (26):

26. I accidentally killed the goldfish in my pond (by pouring tap water into it).
- a) I picked up the garden hose.
 - b) I turned on the faucet that the hose was attached to.
 - c) I poured the water that came out into my pond.
 - d) Chlorine in the tap water diffused into the pond water.
 - e) The chlorine entered my goldfish’s gills.
 - f) It damaged their gills.
 - g) They lost the ability to take in oxygen.
 - h) They died.

Notice that the last five links, (26d-h), are clearly entropic: they follow the natural concentration gradient of the water and of the goldfishes’ metabolism from a high-energy state of initial concentration of chlorine – and live goldfish – to a low-energy state of even diffusion and dead goldfish.

However, the first three links, (26a-c), are not entropic: they do not follow a natural energy gradient in the environment, but rather the Agent/Causer has to supply energy at each link to reach the next one. That is to say, the garden hose did not ‘spontaneously’ pour water into the pond – I had to perform a series of actions that brought this pouring about. Such sequences of events that run contrary to what is expected by entropy are called **negentropic**. They tend to increase the complexity and organization of the universe – in this case, by constructing the causative half of the action chain around my action of pouring water into the pond. Of course, from a purely physical perspective, entropy does increase, since the energy that I expend to perform each action comes from the breakdown of complex molecules into simpler ones by my metabolism, but this level of physical explanation does not make its way into the linguistic expression of the situation. What does make its way into the linguistic expression is a negentropic sequence of my actions.

In fact, what I propose is that all of the examples above have this structure of a negentropic subchain followed by an entropic subchain, as illustrated in Table 2:

Table 2. Entropy-sensitive labeling of causative-inchoative action chain for (9/26)

Causative/negentropic:
I picked up the garden hose
I turned on the faucet that the hose was attached to
I poured the water that came out into my pond
Inchoative/entropic:
Chlorine in the tap water diffused into the pond water
It entered my goldfish's gills
It damaged their gills
They lost the ability to take in oxygen
They died

The negentropic subchain can be seen as a generalization of Langacker's (1990) notion of an action chain which takes the BILLIARD BALL metaphor as its prototypical case: an object/organism is a source of energy which it transmits to a second entity and so on until an entity is reached that absorbs the transferred energy.

V. Chaining together negentropic and entropic subchains

To summarize briefly, I have argued that causative verbs lexicalize situations composed of a negentropic action chain, which can be made explicit by means of a *by* phrase in English, followed by an entropic action chain. A natural question to be asked at this juncture is how the two chains are linked together. In particular, how are they linked together to make a situation that is lexicalizable by a single verb?

Valuable data that aids in formulating an answer can be found by returning to Lakoff's decomposition of causatives in (19), repeated here as (27). The reader may recall that the similarity of meaning of (27a) and (27b) was accounted for by postulating something like (27c) as the meaning for both of them:

- 27 a) John hardened the metal.
 b) John caused the metal to harden.
 c) (John CAUSE (the metal BECOME hardened))

This proposal set off a flurry of debate over the next ten years or so as to whether it is correct or not, *vid.* Fodor (1970), Katz (1970), Shibatani (1972, 1976), Wierzbicka (1975), among others. The conclusion was that it is not correct, at least under the interpretation that the underlying predicates in upper case in (27c) have the exact same behavior as the surface predicates in (27b), for reasons that are reviewed below. The descriptive observation that emerged was that a lexical causative such as (27a) denotes "direct" causation, while a periphrastic causative such as (27b) denotes "indirect" causation. Considerable effort was expended to determine exactly what this notion of directness in causation consisted of, which resulted in the identification of three main constraints, plus a fourth that I deduce from some of that discussion.

The first one can be referred to as Unity of Time, following Wierzbicka (1975). In the periphrastic causative of (28a) the entropic chain takes place at a temporal distance from the negentropic chain, while the lexical causative of (28b) rejects such a discontinuity, *vid.* Fodor (1970:432-3):

- 28 a) Floyd caused the glass to melt on Sunday by heating it on Saturday.
 a') *Floyd melted the glass on Sunday by heating it on Saturday.
 b) John caused Bill to die on Sunday by stabbing him on Saturday.
 b') *John killed Bill on Sunday by stabbing him on Saturday.

The other two minimal pairs show the same pattern of grammaticality.

Given the strong correlation of time and space in natural languages, one would expect a corresponding constraint of Unity of Space. Indeed, such a constraint is found, as attested by the minimal pair from Fillmore (1975:4) in (29):

- 29 a) Peter caused the cat to die in the attic.
a') Peter killed the cat in the attic.

The difference between the two is that, in the latter, Peter has to be in the attic along with the cat, while in the former, he does not. Wierzbicka (1975:495) intuitively finds a similar restriction on the pair in (30):

- 30 a) Peter caused Harry to die from the top of a baobab.
a') ?Peter killed Harry from the top of a baobab.

To the extent that (30a') is acceptable, it must be interpreted as abbreviating some spatial connection between the two participants, such as "Peter killed Harry by shooting him from the top of a baobab." Note the contrast with (30a); in the latter, Harry can be at an arbitrary spatial remove from Peter's perch high atop the baobab.

The third constraint is found in the fact that there cannot be a causer closer to the entropic subchain than the one lexicalized as the subject, as the pair from Jackendoff (1972:28) in (31) shows:

- 31 a) Floyd caused the glass to drop to the floor by tickling Sally, who was holding it.
b) *Floyd dropped the glass to the floor by tickling Sally, who was holding it.

In other words, the subchains of direct causation must share the same causer.

The fourth and final constraint can be deduced from what Chomsky (1970:218) and Wierzbicka (1975:492) call 'eventive' or 'hidden event' causation, illustrated in (32):

- 32 a) John's clumsiness caused {the door to open/the window to break}.
a') *John's clumsiness {opened the door/broke the window}.
b) John's clumsiness caused some milk to be spilled.
b') ?John's clumsiness spilled some milk.
c) John's absentmindedness caused the toast to be burned.
c') ?John's absentmindedness burnt the toast.

At first glance, it appears that an abstract noun can not be the subject of lexical causatives. However, Yang (1976:58) points out that (32a') can be brought into grammaticality by highlighting a clausal interpretation for the abstract noun:

33. John's clumsiness in shutting the window broke it. (9a)

Nevertheless, a consideration of what action chains could be lexicalized in (32) vs. (33) indicates that what palliates the ungrammaticality of the lexical causatives in (32) is the degree or eventive reading of the abstract noun in (33), not just its clausal status. (34) and (35) are offered as potential action chains for (32a') and (33), respectively:

34. John's clumsiness broke the window
a) John is clumsy.
b) ?
c) The window broke.
35. John's clumsiness in shutting the window broke it
a) John shut the window by pressing down hard on one side and then the other.
b) This was a (very) clumsy way to shut a window.
c) The stress on the window overcame the strength of its internal structure.
d) The window broke.

The lack of continuity in (34) jumps out at one. The target sentence gives no clue as to how to go from the affirmation of a property of John to an event of window-breaking. In contrast, the extra material in (35) brings out a degree reading of 'clumsiness' and so allows it to be interpreted as something akin to a nominalized adverb, with the verb that it modifies in the subordinate clause

supplying the missing negentropic chain. Since the periphrastic causatives of (32) are not constrained in this manner, we may tentatively conclude that direct causation does not tolerate ‘gaps’ in the lexicalized action chains.

All four constraints are summarized in Table 3:

Table 3. Constraints on the linking of negentropic and entropic chains

	Direct causation/Lexical causative	Indirect causation/Periphrastic causative
Time	Subchains must occur at same time	Subchains can occur at different times
Space	Subchains must occur in same space	Subchains can occur in different spaces
Causer	Subchains must involve same causer	Subchains can involve different causers
Connectedness	Subchains must be connected (they cannot have gaps)	Subchains need not be connected

Wierzbicka suggests that Unity of Time and of Space can be combined into a single complex constraint of Physical Contact: the Agent must come into physical contact with the Patient of the causative situation. Consider (36a’), in which the stray bullet is understood as striking Harry, while this is not necessarily the case in (36a).

- 36 a) A stray bullet caused Harry to die.
 a’) A stray bullet killed Harry.
 b) A TNT explosion caused Harry to die.
 b’) A TNT explosion killed Harry.

Likewise, in (36b’), the TNT explosion must overtake Harry, while this is not necessarily the case in (36b). For instance, Harry could die of heart attack caused by the fright of hearing an explosion unexpectedly.

Physical Contact also explains why environmental causes cannot be lexicalized, as seen in the following pairs from Partee (1985[Hall 1965]):

- 37 a) The low air pressure caused the water to boil. (2-33)
 a’) *The low air pressure boiled the water. (2-34)
 b) The angle at which the door was mounted caused it to open whenever it wasn’t latched.(2-35)
 b’) *The angle at which the door was mounted opened it whenever it wasn’t latched. (2-36)

Nor do internal forces do lead to successful lexicalization:

- 38 a) A change in molecular structure caused the window to break. (2-31)
 a’) *A change in molecular structure broke the window. (2-32)

It is helpful to remind the reader at this point that Wierzbicka’s notion of Physical Contact is highly reminiscent of Langacker’s (1990) claim that the BILLIARD BALL metaphor is the prototypical case of causation.

Nevertheless, there are two classes of systematic counterexamples to the super-constraint of Physical Contact: magical causation, and experiencer causatives, which are reviewed briefly in the following paragraphs.

‘Magical’ causation, as pointed out in Wierzbicka (1975), does not involve physical contact:

- 39 George killed Harry by magic.

Of course, exactly what kind of instrumentality it does involve is unclear, so this sort of causation must be left for future research.

Experiencer causatives such as *amuse* in (36), also do not involve any physical contact, vid. N. McCawley (1976):

- 40 a) Mary amuses John by telling silly stories.
 a’) Mary amuses John (with her silly stories).
 b) It amuses John that Mary told such silly stories.

Nevertheless, the usage of *amuse* without a sentential subject as in (40a) obeys Unity of Time, whereas the usage of (40b) does not:

- 41 a) Mary caused John to be amused today by having told silly stories yesterday.
a') *Mary amused John today by having told silly stories yesterday.
b) It causes John to be amused today that Mary told such silly stories yesterday
b') It amuses John today that Mary told such silly stories yesterday.

Moreover, one can postulate an action chain like that of (42) to elucidate the entire situation to be lexicalized:

42. Mary amused John (by telling silly stories)
a) Mary told silly stories.
b) John heard the stories.
c) They related to his experiences in such a way as to be amusing.
d) He became amused.

Again, there is a negentropic first half – the telling of stories, which can only be done by expending energy – and an entropic second half – the stories follow a natural gradient in John's psyche which ends in his amusement. Experiencer causatives may therefore be amenable to incorporation into the model that was developed above for 'physical' causatives, but the literature on these constructions is so large that this claim must be left for future examination.

With this background, we can make sense of the data in (43), also from Wierzbicka (1975:492), in which abstract nouns cause inchoative results in the absence of physical contact and with no lessening of grammaticality:

- 43 a) John's cruelty killed his wife.
b) Her charm opened all doors.
c) Her tactlessness closed against her all the doors of polite society.
d) His brutality hardened her heart.
e) Her shyness softened his heart.

These appear to be experiencer causatives in which the physical causative is used metaphorically. A first approximation to the kinds of action chains lexicalized in such cases is given in (44) for (43a) and (45) for (43b):

44. John's cruelty killed his wife
a) John humiliated his wife.
b) He beat her.
c) He did not let her see her friends or family.
d) All of this is cruel.
e) She felt desperate and hopeless.
f) She died/She killed herself.
45. Her charm opened all doors
a) She flatters people.
b) She makes people feel comfortable.
c) She is witty and easy to get along with.
d) All of this is charming.
e) People want to be with charming people like her.
f) They give her access to private domains.
g) A PRIVATE DOMAIN IS A CLOSED DOOR.
g') TO GIVE ACCESS TO A PRIVATE DOMAIN IS TO OPEN A DOOR.

Both chains begin with obviously negentropic subchains which are experienced and lead predictably, i.e. entropically, to a psychological response that is lexicalized, perhaps metaphorically, by the causative verb. I hedge because it is not entirely clear to me what metaphor is realized by 'to kill' in

(44), though the metaphor realized by 'to open a door' is clear to me in (45), and is given by the capitalized material in (45g,g').

VI. Summary and conclusions

To summarize, this paper proposes that causative-inchoative verbs lexicalize an action chain consisting of a negentropic subchain that realizes the abstract predicate CAUSE, followed by and composed with an entropic subchain that realizes the abstract predicate BECOME. By "negentropic subchain", we mean a series of events that do not happen 'naturally' or 'spontaneously', but rather by the expenditure of energy on the part of the causer at every link in the chain. By "entropic subchain", we mean a series of events that do happen 'naturally' or 'spontaneously', by following some gradient in the environment from a high-energy to a low-energy state. Four kinds of environmental gradients have been discussed. The first and presumably privileged one involves objects governed by common-sense physics, such as falling and melting. The second involves ingestion of a poisonous substance and the consequent metabolic effects, which can lead to the low-energy state of **death**, if the substance is poisonous enough. The third involves the perturbation of highly organized social structures, which settle into a low-energy – read less organized or ruined – state. The fourth involves the experiencing of a stimulus and the consequent psychological reaction, which is assumed to follow inevitably from the experiencer's psychic make-up.

Moreover, we have been able to identify four constraints on how the negentropic and entropic subchains are composed into an entire chain to be lexicalized by a single verb. This can only happen if the two subchains obtain at the same place and time, with the same causer, and without gaps.

Finally, these results should be viewed in the perspective of my larger research program on the internal cognitive complexity of single morphemes. The connectedness constraint hints at the general source of explanation: cognitive entities are structured mereotopologically, which means that they are composed of parts which are internally connected. This in turn follows from the structure of the brain: neurons can be modeled by locally connected oscillators, so that a group of locally-connected oscillators oscillating at the same frequency represents a single cognitive object. Unfortunately, explaining this in the requisite detail would itself require an entire paper at least of the length of this one, so the interested reader is referred to my Web page for additional information.

VII. References

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