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The Aspectual Interface Hypothesis

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1.1 Introduction: The Linking Problem

The problem of the linking of thematic roles to syntactic argument positions is of fundamental importance because it is part of the larger problem of the connection between syntax and semantics. Theories of generative grammar have adopted, to a greater or lesser extent, the view of an autonomous syntax operating independently from the semantics of a language. Up to a certain point, this view does seem to characterize the behavior of natural language. However, the problem remains that, in spite of the evidence for the autonomy of syntax and semantics, there are strong generalizations to be made about correspondences between meaning and syntactic structure. There are familiar facts that cannot be ignored; such as the fact that in general, agents are subjects, and themes or patients are objects. Lexical semantics and syntax clearly interact—the problem is how to constrain that interaction. Various mechanisms that have been proposed to deal with this, such as lists of linking rules that connect particular thematic roles with particular syntactic or configurational argument positions, are somewhat stipulative and not entirely satisfactory. More principled approaches to the problem have been presented in the recent literature, in the form of hypotheses that there are uniform and universal constraints on the mapping between syntax and lexical semantics. Perlmutter and Postal (1984) proposed the Universal Alignment Hypothesis (UAH) in the framework of Relational Grammar:

This paper is a 1989 revision of material, some of which was presented at LSA 1987 and NELS 1987 and appears in *Proceedings of NELS 18*, published by University of Massachusetts at Amherst. I am grateful to audiences at these meetings for their comments. I have also benefited from comments by Jane Grimshaw, Beth Levin, James Pustejovsky, Malka Rappaport, Anna Szabolcsi, and Robert Van Valin. This work has been supported by grants from the System Development Foundation and from the Kapor Family Foundation. I am grateful for their support.

Lexical Matters. Ivan A. Sag and Anna Szabolcsi, eds.
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Universal Alignment Hypothesis (UAH): There exist principles of universal grammar which predict the initial relation borne by each nominal in a given clause from the meaning of the clause.

And Baker (1985) proposed the Universal Theta Assignment Hypothesis (UTAH), in the framework of Government and Binding Theory:

Universal Theta Assignment Hypothesis (UTAH): Identical thematic relationships between items are represented by identical structural relationships between those items at the level of D-structure.

Both of these hypotheses propose a fundamental connection between "meaning" and some level of syntactic representation. The UAH maintains that general principles constraining the mapping from lexical semantics to syntax do exist, although it gives no indication of what they might be. The UTAH claims that the mapping between thematic and structural relationships is consistent, although it does not explain why the mapping is the way it is. The UAH and the UTAH are elegant ideas that explain a variety of phenomena in a simple way. However, these hypotheses lack an account of the central mechanism by which thematic structures and syntactic structures are connected. The thesis of this paper is that certain aspectual properties mediate between syntax and lexical semantics, and provide a principled basis for hypotheses such as the UAH and the UTAH. The Aspectual Interface Hypothesis (AIH) is proposed to supplant the UAH and the UTAH:

Aspectual Interface Hypothesis: The mapping between thematic structure and syntactic argument structure is governed by aspectual properties. A universal aspectual structure associated with internal (direct), external and oblique arguments in syntactic structure constrains the kinds of event participants that can occupy these positions. Only the aspectual part of thematic structure is visible to the syntax.

This proposal takes a strong stand on the current controversy over whether grammar needs to refer to thematic roles. Under this view, the syntax proper does not need to "see" thematic roles. It only "sees" certain syntactic/aspectual structures the thematic roles are associated with.

This is also in the spirit of much recent work arguing that the thematic content of thematic roles need not be referred to by syntactic operations. (See Belletti and Rizzi 1988; Rappaport and Levin 1988; Levin and Rappaport 1986; Grimshaw 1987a; Rappaport, Laughren, and Levin 1987.)

This paper focuses on the central part of the aspectual structure proposed by the AIH: the correspondence between the argument in a semantic representation which has the special aspectual role of "measuring out the event," and the syntactic argument which may be characterized as the verb's internal argument. The crucial constraint on this correspondence may be stated as:

(1) The internal argument of a simple verb is constrained so that it either undergoes no change or motion, or it undergoes change or motion which "measures out the event" over time.

The statement above may be regarded as one clause in a fully articulated set of principles of aspectual structure. The discussion in this paper is concerned with simple nonstative verbs (although (1) is true of stative verbs as well). Verbs with more complicated argument structures, such as propositional-argument-taking verbs, are unexplored in this paper and must await further research.

Section 1.2 outlines some assumptions about lexical and argument structure on which the discussion in the paper depends. Then in Section 2, various lexical semantic phenomena are discussed which illustrate the special aspectual role of the internal argument. These include affectedness, unaccusativity, the locative alternation, and psych verbs. Section 3 addresses the question of what the AIH says about thematic roles. Section 4 considers the implications of the AIH for language acquisition, and points out some constraints it places on the lexicon.

1.2 Some Assumptions

The AIH as stated above adopts a certain view of argument structure and lexical structure. It employs some ideas developed in the work of the MIT Lexicon Project. The MIT Lexicon Project has been investigating what information must be included in the lexical entry for a natural language predicate; or (to look at it another way) what a native speaker must know about predicates in his or her language, in order to be able to use them correctly. (Hale and Keyser 1987; Rappaport and Levin 1986; Rappaport, Laughren and Levin 1987.) A structured lexical entry has been developed which has two parts: a structural part and a conceptual part. For example, Hale and Keyser (1988) show the lexical entry for *cut* as in Figure 1.

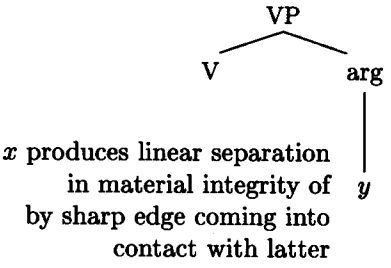

Figure 1 Lexical Entry for English *cut*

The prose part of the entry expresses the conceptual part of the verb's meaning, including the number of open arguments and the roles they play

in the event described by the verb. (Notice that thematic roles *per se* are not mentioned.) The structural part indicates how these roles are to be mapped onto syntactic structures. The tree-like structure simply indicates that the "*y*" argument must be the syntactic object of the verb. What is crucial here is that the verbal entry has two parts: a semantic/conceptual part and a syntactic/structural part; and it indicates the nature of the correspondence between them. The AIH drives that correspondence, and it has as a consequence the requirement that the argument linked to the verb's direct object position must be aspectually constrained.

The view of argument structure assumed here includes a distinction between external and internal arguments, and a distinction between direct internal and indirect internal arguments. (See Williams 1980 on external arguments.) External or internal argumenthood is essentially a syntactic property. Argument structures are assumed to map onto syntactic structures in a straightforward way, so that internal and external argumenthood may be equated with syntactic positions. The expression "syntactic argument structure" is used here to refer to these arguments mapped onto their syntactic positions. In this paper the syntactic consequences of the AIH are cast in the framework of Government and Binding Theory, but this is not essential. I believe they may also be expressed in other syntactic frameworks.

Employing the tools of Government and Binding Theory, external arguments are generated outside the verb phrase and are not governed by the verb at D-structure. Internal arguments are generated within the verb phrase. Direct internal arguments are generated as structural objects of the verb, and are assigned structural case by the verb, while internal indirect arguments (oblique arguments) do not receive structural case from the verb. Instead they are assigned inherent case or are assigned case by a preposition. These three argument-types—external, direct, and oblique—are assumed to be associated with these distinctive syntactic positions. I believe these definitions of external, direct and oblique arguments may be translated into other frameworks. What is necessary is simply that there be some representation of argument structure which includes aspectual information, and which has some clear mapping to syntax.

2.1 Aspect and the Internal Argument

In the theory presented here, the crucial aspectual property is associated with the direct internal argument of a verb. The direct internal argument of a verb of change "measures out" over time the event described by the verb. The verb's direct internal argument may be thought of as being converted into a function of time at some level of semantic representation. This is an aspectual property, because aspect refers to the internal temporal organization of an event. The term "measures out" is used here in an informal sense, as a convenient metaphor for uniform and consistent change, such as change

along a scale. The idea of an object measuring out an event can be elucidated using the aspectual property of delimitedness. A delimited event is one that the language encodes as having an endpoint in time. The aspectual distinction between delimited and nondelimited events has a long history of discussion in the philosophical and linguistic literature, dating back to Aristotle. (Particularly notable in the recent literature are Vendler 1967, Dowty 1979, Hinrichs 1985, and Verkuyl 1972, 1976, 1978, 1987ab.) The difference between delimited and nondelimited events is illustrated in (2) and (3).

(2) Delimited:
   a. destroy the city (in an hour/*for an hour)
   b. climb a tree (in an hour/?for an hour)

(3) Nondelimited:
   a. like jazz (*in a day/for a day)
   b. push the car (*in an hour/for an hour)

The events described by the verb phrases in (2a) and (2b) are delimited events; those in (3a) and (3b) are nondelimited events. Temporal adverbial expressions such as *in an hour* and *for an hour* are useful in distinguishing between a delimited and a nondelimited reading.[1]

Now consider the verb phrases below. In their salient readings, these describe delimited events:[2]

(4) a. perform a play
   b. translate a poem

Not only do these events have temporal bounds, but these bounds are provided by the referent of the internal argument. In other words, it is the object that delimits the event. When you perform a play, you perform act one, then act two, and so on, until you come to the end of the play. The end of the play is the end of the event. Likewise, in translating a poem, one may translate the first stanza, then the second stanza, then the third, until the end of the poem is reached and the translation event is over.

A very coarse test for this idea is provided by certain adverbials such as *halfway*, which make reference to a kind of measurement:

(5) a. perform a play halfway
   b. perform half a play
   c. translate a poem halfway
   d. translate half a poem
   e. destroy the city halfway
   f. destroy half the city

[1]These adverbial expressions, however, are sensitive to lexical subtleties that make them imperfect diagnostics of delimitedness. The definition of delimitedness must be based on the existence of an understood temporal bound to the event, rather than solely on tests using adverbials.

[2]Some speakers find these to be vague between a delimited and a nondelimited reading.

Although the two verb phrases in each couplet do not mean exactly the same thing, in each pair the second verb phrase represents one possible way to understand the first. That is, *halfway through the event* may be equated with *half of the object*.

In the examples above, the direct internal argument measures out the event through its spatial extent or volume. This makes these examples particularly clear. However, the argument need not measure out the event through its spatial extent or volume; some other property of the object may measure out the event, as in (6) below:

(6) a. redden the photograph
b. ripen the fruit

In (6a) it is the redness of the object, and in (6b) it is the ripeness of the object that measures out the event. In both cases the verb names that property of its argument which is to do the measuring.

The direct internal arguments in the verb phrases in (3) through (5) above measure out and delimit the event described by the verb. However, under the theory proposed here, all direct internal arguments undergoing change are constrained to measure out the event, whether or not it is a delimited event.

Consider (7) below:

(7) a. push the cart (*in an hour/for an hour)
b. push the cart to New York (in an hour/?for an hour)

In (7a), the verb and its direct internal argument describe a nondelimited event, rather than a delimited one. In (7b) however, with the addition of a goal phrase (an indirect internal argument) the event becomes delimited. Nevertheless, the cart still measures out the event in both of these expressions. The delimitedness of (7b) is achieved through reference to the very property of the direct internal argument that is measuring out the event: namely, its location. The indirect internal argument—or the goal phrase—delimits the event by referring to that property of the direct argument that is undergoing the central change in the event. Example (7) above illustrates how the arguments of verbs that describe nondelimited events may be unified with arguments of verbs describing delimited events such as those in (3), (4) and (5). Verbs such as *push* may be subsumed under the condition that the direct internal argument of the verb is constrained to measure out the event through a change in a single property. The change in the direct internal argument during the course of the event must be describable as a change in a single property. The event may be delimited linguistically through reference to that change or that property.

To summarize the discussion thus far, the following hypotheses have been made. All direct internal arguments undergoing change in the event described by the verb measure out the event. Direct arguments are distinguished arguments in this respect. With some verbs (*perform*, *translate*,

destroy, *redden*, *ripen*) the direct internal argument measures out and delimits the event. With other verbs (*push*) the direct internal argument measures out the event and an indirect internal argument may delimit it. Only internal arguments can delimit the event, and they can do this only by reference to the measuring performed by the direct internal argument.

Various elements of the idea proposed in this paper—that an internal argument measures out an event—may be found in Gruber 1976; Jackendoff 1987; Dowty 1979, 1988; Krifka 1987; Verkuyl 1972, 1976, 1978, 1987ab; Hinrichs 1985; and Pustejovsky 1988.[3] However, none of these authors has extended the idea to include internal arguments in general, or employed the idea as a truly general principle of correspondence between syntactic structure and semantics.

The idea that only the direct internal argument measures out the event explains an asymmetry between internal and external arguments regarding the interaction of the aspectual properties of NP's and VP's. There is an interesting asymmetry between internal and external arguments in the interaction of mass noun arguments with delimitedness. There is a class of verbs which translate count-ness of the internal argument into delimited-ness of the event.[4] When the internal argument is a count noun the event is delimited (8a), and when it is a mass noun it is nondelimited (8b). The internal arguments are underlined in (8) below:

(8) a. Charles drank *a mug of beer* (??for an hour/in an hour). (delimited)
b. Charles drank *beer* (for an hour/*in an hour). (nondelimited)

To the best of my knowledge there is no corresponding class of verbs that translate count-ness of the external argument into delimited-ness of the event. Whether the external arguments underlined in (9) and (10) are mass or count nouns has no effect on the delimited-ness of the event:

(9) a. *The heater* melted the candle. (delimited)
b. *Heat* melted the candle. (delimited)

(10) a. *Snow* surrounds the house. (nondelimited)
b. *Seven trees* surround the house. (nondelimited)

[3]Krifka (1987) and Hinrichs (1985) have written on certain delimiting predicates which, roughly speaking, express homomorphisms from their arguments to the events they describe. Dowty (1991) has employed this idea as one contributing property for the Proto-Patient Role, mapping "incremental themes" (such as *house* in *build a house*) onto the Proto-Patient role. (See Section 2.7.)

[4]It is well known that bare plurals in either subject or object position affect the aspectual properties of a sentence. A bare plural subject or object makes it possible for the sentence to describe some event of indefinite duration. Bare plurals, which behave like mass nouns in many respects, do not exhibit the subject/object asymmetry described above. They must be considered a separate phenomenon for the purpose of this discussion.

Mass/count properties of internal arguments but not of external arguments interact with the aspectual properties of verb phrases and sentences. This asymmetry between internal and external arguments makes sense in light of the requirement that only internal arguments measure out events.[5]

2.2 Affectedness

The property of affectedness has been much discussed in the literature lately. Affectedness is interesting for two reasons: (i) because it is a semantic property that has been implicated in certain syntactic phenomena, and (ii) because it is always associated with direct internal arguments. An affected argument has been generally described as an argument which undergoes some change. Undergoing change is a temporal process. An affected argument can be more adequately described in aspectual terms, as an argument which measures out and delimits the event described by the verb. An affected argument measures out the event by virtue of its being a direct internal argument. What is special about it is that it also delimits the event. The characterization of these arguments as delimiting the event unifies a larger class of verbs having the same syntactic behaviors than does the idea of being affected by some action. Although this fact does not explain why these syntactic behaviors correlate with aspectual properties, it does explain why the crucial aspectual property is associated with the direct internal argument.

The correlation of affectedness with delimited-ness can be illustrated by considering some of the syntactic phenomena in which affectedness has been implicated. Among the syntactic phenomena that affectedness is relevant to are middle formation and NP passivization. (See Anderson 1979, Roberts 1985, and Hale and Keyser 1987 on these topics. The aspectual nature of the affectedness constraint on NP-passivization has also been noted by Fellbaum (1987).) Consider the NP-passives in (11) and (12).

(11) a. The Mongols' destruction of the city.
b. The city's destruction by the Mongols.
c. The missionaries' conversion of the natives.
d. The natives' conversion by the missionaries.

(12) a. John's avoidance of Bill.
b.*Bill's avoidance by John.
c. Sally's pursuit of the cat.
d.*The cat's pursuit by Sally.
(M. Anderson 1979 (=(51),(53)))

In (11) the arguments are affected and NP passivization is possible. In (12), where the arguments are not affected, NP passivization does not yield good

[5]A full account of this phenomenon must be cast in a sound theory of mass- and count-ness, and is beyond the scope of this paper.

expressions. The possibility of NP-passivization correlates closely with the delimited or nondelimited-ness of the event. This is shown in (13) by the applicability of temporal adverbials:

(13) a. destroy the city in a day/*for a day
(the city's destruction in a day/*for a day)
b. convert the natives in a month/??for a month
(the native's conversion by the missionaries in a month/*for a month)
c. avoid Bill *in an hour/for an hour.
d. pursue the cat *in an hour/for an hour.

Not only do (13a) and (13b) describe delimited events, but they describe events delimited by the change in the argument. The argument measures out and delimits the events in these examples.

The property that governs NP-passivization is actually an aspectual property. This explains why some verbs like *perform* take NP-passives when they do not actually seem to affect their arguments, as in (14).

(14) a. The company's performance of the play.
b. The play's performance by the company.
(M. Anderson 1979 (=(48)))
c. John's translation of the poem.
d. The poem's translation by John.

An aspectual definition of an affected argument as a delimiting argument unifies a wider range of relevant data than a definition based on the notion of being affected by some action.

Now consider the middles in (15) and (16).

(15) a. This door opens easily (by pulling on the handle).
b. This cinch tightens easily (if you give it a good yank).
(after Hale and Keyser 1987)
c. This door opens easily in a minute/?for a minute.
d. This cinch tightens easily in a minute/?for a minute.

(16) a.*The traffic jam avoids easily.
b.*Fleeing burglars pursue easily.
c. avoid the traffic jam *in a minute/for a minute
d. pursue the burglar *in an hour/for an hour

In (15) the arguments are affected arguments, and middles are possible. In (16) they are unaffected and middles are not possible. Again, in (15) the possibility of middle formation correlates with the delimited-ness of the event, and in (16) the impossibility of middle formation correlates with the nondelimited-ness of the event, as shown by the adverbials. The arguments in (15) are delimiting and those in (16) are nondelimiting.

The distinction between delimiting and nondelimiting arguments explains the difference in judgments speakers assign to the sentences in (17).

(17) a. The desert crosses easily for settlers with large wagons.
b.*The desert wanders easily for settlers with large wagons.
c. The globe circumnavigates in a day/easily with Pan Am
d.*The globe travels in a day/easily with Pan Am.
e. The enemy battalion infiltrated surprisingly easily for the guerrilla soldiers.
f.*The enemy battalion pursued surprisingly easily for the guerrilla soldiers.

Although judgments about middles are notoriously murky, most speakers agree with the relative grammaticality judgments illustrated here.[6]

The examples above show that affected arguments are delimiting arguments, and the notion of delimiting argument is more appropriate than that of affected argument as a criterion for syntactic behavior. It is well-known that affected arguments are always direct internal arguments of the verb. This is predicted by a theory in which direct internal arguments measure out events. Affected arguments are a subset of the class of direct internal arguments; they are those arguments that not only measure out but also delimit the event.

To summarize, the aspectual constraints on internal arguments give us a handle on the semantic property of affectedness, predict that affected argu-

[6]The delimiting argument constraint on middles and NP-passivization predicts that the same class of verbs will enter into both of these constructions. This prediction is by and large borne out. Verbs that form middles also form NP-passives:

(i) the desert's crossing by settlers with large wagons
(ii)*the desert's wandering by settlers with large wagons
(iii) the globe's circumnavigation by Pan Am
(iv)*the globe's traveling by Pan Am
(v) the enemy battalion's infiltration by the guerrilla soldiers
(vi)*the enemy battalion's pursuit by the guerrilla soldiers

Verbs that form NP-passives (i-iv below) form relatively good middles compared to verbs which do not form NP-passives (v and vi below), but middle formation is not as productive as NP-passivization:

(i)?Shakespeare's Othello performs more easily with a good company than with a bad one.
(ii) Haiku poetry does not translate at all.
(iii)??European explorers found that natives convert with the sword more easily than with the word.
(iv) (??)(*)The munitions research industry predicts that major cities will destroy quickly and effortlessly with the weapons of the future.
(v)*Policemen avoid easily in a crowd.
(vi)*Burglars pursue easily on foot.

Examples (i), (ii), and (iv) above are poor to unacceptable for most speakers but they improve with exposure. Middle formation appears to be slightly more constrained than NP-passivization. Since speakers' judgments about middles show so much variability, it is likely that there are additional subtle factors at work with middles. It is also possible that middle formation is more of a lexical phenomenon than NP passivization. Nevertheless, the delimiting constraint picks out by and large the correct class of verbs for both middle formation and NP-passivization.

ments should be internal arguments, and substitute the notion of delimiting argument for affected argument as a criterion for certain kinds of syntactic behavior. And although the reason for the interaction of delimited-ness with middle-formation and NP-passivization is still obscure, recognition of the fact that delimited-ness has syntactic properties is a step towards a deeper understanding of the syntax of these constructions.

2.3 Unaccusative and Unergative Verbs

Following the Unaccusative Hypothesis, unaccusative verbs are verbs whose sole argument is an internal direct argument, while unergative verbs have an external argument as their sole argument. (The Unaccusative Hypothesis and the representation of unaccusativity in syntactic theory is discussed by Perlmutter and Postal 1984 and Burzio 1986. For contrasting views and problems, see Van Valin 1987 and Zaenen 1987. For a useful overview of issues see Grimshaw 1987b.) These two classes of verbs constitute a minimal pair with which to investigate the properties of internal and external arguments. The internal or external status of the arguments of unaccusative and unergative verbs is a syntactic fact. However, it is well known that there are strong general semantic tendencies associated with this syntactic distinction. Unergative verbs are usually verbs in which the argument engages in some kind of volitional activity, while unaccusative verbs describe situations in which the argument undergoes some kind of change. Unaccusatives usually assign a patient or theme thematic role to their argument, while unergatives more often than not assign agent thematic roles. These familiar facts are illustrated by the following examples:

(18) a. unergatives: (external arguments; agent)
run, dance, whisper, bicycle, study
b. unaccusatives/ergatives: (internal arguments; patient, theme)
melt, freeze, evaporate, fall, open, collapse

In a model of grammar in which syntax and semantics are strictly autonomous, such a correlation of semantic properties with syntactic structures is difficult to express. In a model in which a wide range of semantic properties is visible to the syntax, the connection between syntax and semantics is difficult to constrain. The semantic generalizations about these verbs are too strong to ignore. The proposal that the internal argument is constrained to measure out the event provides a simple explanation. There are differing aspectual constraints on internal and external arguments, and these aspectual constraints affect what types of thematic roles may occupy those positions. Applying the adverbial *halfway* brings out a difference between unaccusatives and unergatives:

(19) a.*Martha danced halfway.
*Thomas ate halfway.
*Jack whispered halfway.

b. The lake froze halfway.
The candle melted halfway.
The barn collapsed halfway.

Halfway applies naturally to the unaccusatives in (19b) but not to the unergatives in (19a).[7]

Adverbial phrases such as *a little bit at a time*, or *a lot at once* provide additional tests. These are illustrated in (20) and (21).

(20) a. The dancer danced slowly/*a little bit at a time.
The announcer talked slowly/*a little bit at a time.
The actress whispered slowly/*a little bit at a time.
b. The candle melted slowly/a little bit at a time.
The lake froze slowly/a little bit at a time.
The barn collapsed slowly/a little bit at a time.

(21) a.??Martha danced quickly, a lot of her dancing at once.
??The announcer talked quickly, a lot of him talking at once.
??The actress whispered quickly, a lot of her whispering at once.
b. The candle melted quickly, a lot of it melting at once.
The lake froze quickly, a lot of it freezing at once.
The barn collapsed quickly, a lot of it collapsing at once.

These expressions are awkward when used in conjunction with an unergative verb, but quite natural when used with unaccusative verbs.[8]

The proposal that the internal argument is constrained to measure out the event through some property it possesses, while the external argument is not so constrained, explains the semantic distribution of verb meanings across unergative and unaccusative verb classes. Those verb meanings which become unaccusative verbs describe exactly those event types in which the event participant may be construed as measuring out the event. Verb meanings in which the event participant may not be construed as measuring out the event must become unergative verbs. And finally there will be a class of verb meanings that may be construed in either way, and these will be unaccusative in some languages and unergative in other languages. This is the nature of the correlation that is attested cross-linguistically. (Merlan 1985 examines this question in detail.) The view advanced here of the connection between lexical semantics and syntactic argument structure predicts this. It maintains that there is no absolute mapping from verb meanings to syntactic argument structure. Rather, there is a kind of

[7]There is a special sense of *Martha danced halfway* which is acceptable—namely that in which Martha dances halfway to some destination. But in this case the property which is measuring out the event (location), although it is changing in the external argument (Martha), can only be expressed in its pure form through an internal argument, as in *Martha danced half the distance (home)*.

[8]There are some verbs to which these adverbials do not easily apply. Additional tests need to be devised. The reader is reminded that the adverbials serve only to elucidate the aspectual properties of internal arguments. They are not diagnostics.

event template associated with argument structure that acts as a filter on verb meanings. This event template consists of a set of universal aspectual principles of argument structure, including the principle that the internal argument measures out the event.[9]

Van Valin (1987) showed that the aspectual properties of verbs can be used to determine their class membership in the unaccusative or unergative verb classes, and that Dowty's aspectual calculus for lexical decomposition is an effective language for doing so. The theory proposed here has much in common with Van Valin's proposal, but it differs in two crucial ways. In both theories there is a mapping from aspectual properties to syntax, directly or indirectly. But according to Van Valin, the mapping from aspectual properties of verbs to syntax is constrained only in that aspectual properties must be statable in a Dowty-style calculus. These constraints may be language-particular. Under the view advanced here there is one overriding and universal aspectual constraint; that the internal argument, associated with the D-structural object position, measures out the event. The internal argument must be convertible into a (nontrivial) function of time. This overriding aspectual constraint unifies unaccusativity with other verbal phenomena. The two views are not incompatible, however, since within the limits of this general aspectual constraint, there is room for a variety of mappings from Dowty-style aspectual properties into syntax. Secondly, under the theory proposed here (which adopts the Unaccusative Hypothesis) aspectual properties are directly correlated with syntactic structures. This view says that certain aspectual properties are in fact syntactic properties, and predicts that further repercussions of these properties may be found in syntax.

The aspectual properties of internal and external arguments also provide a reason for the familiar fact that agents are never direct internal arguments.[10] Agents are a type of event participant which are inherently

[9]One might say, taking this view, that there is a mapping from verb meanings to aspectual structure. However, without a pre-aspectual theory of verb meanings it would be impossible to describe this as an absolute mapping. Even with such a theory it may not be possible, since factors as imprecise as religious or cultural views may influence what type of aspectual properties certain kinds of events are perceived by language speakers to have. It must be emphasized that this theory does not provide the tools for a perfect and absolute mapping from pre-aspectual verb meanings to syntactic structures. In a certain sense it preserves the essential autonomy of syntax and semantics.

[10]Two well-known potential counterexamples to this generalization are syntactically ergative languages, and certain lexical causatives. There is some doubt among researchers on Australian and Eskimo languages that syntactically ergative languages do exist. (Jane Simpson (personal communication) and Alana Johns (personal communication), respectively. Also see Heath 1979 on Dyirbal.) However, if there are true syntactically ergative languages, they pose an interesting problem for the AIH. In most general terms, the AIH requires that there be a distinction between arguments that measure out the event and those that do not, and that this distinction correlates with syntactic structure. Furthermore, the argument that measures out the event

unsuited to measuring out an event on a scale. An agent by its very nature is free to act in unspecified ways to effect something. The actions required of an agent are underspecified and also not necessarily consistent throughout an event, and so are not naturally construable as a scale on which something could be measured.

2.4 The Locative Alternation

Next consider the locative alternation, investigated by Schwartz-Norman (1976), S. Anderson (1977), and Rappaport and Levin (1986). The verbs that participate in this alternation are verbs which take a goal and a theme argument, either of which can be the direct argument of the verb. For example:

(22) a. spray paint on the wall
b. spray the wall with paint

Either the goal, *wall*, or the theme, *paint*, can be the direct argument of the verb *spray*. Only a very particular class of verbs show this alternation. Not all verbs that have a goal and a theme argument can undergo this alternation. The verb *push* also takes a goal and a theme, but the alternation is not possible in (23):

(23) a. push a cart to San Francisco
b.*push San Francisco with a cart

The possibility of the locative alternation seems to depend on a very narrow semantic property; the goal must be a flat surface or container, and the theme must be a material which is removed or applied to that surface or container. The verbs in (24) illustrate these properties:

(24) a. load hay on the wagon
b. load the wagon with hay
c. clear dishes from the table
d. clear the table of dishes
e. cram pencils into the jar
f. cram the jar with pencils

Furthermore, this generalization holds across a wide variety of unrelated languages. Examples (25) and (26) illustrate the alternation in Dutch and Japanese:

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must be closer syntactically to the verb than arguments that do not. If there are languages in which the agent is closer to the verb than the theme (under deep syntactic analysis) then this requirement is violated. If such languages exist, the details of this mapping from aspectual structure into syntactic structure would have to be revised. The second case is that of lexical causatives such as *gallop* in *John galloped the horse*, where the internal argument, the horse, has agentive powers. Nevertheless, in this sentence the horse's change of location is measuring out the event. (Consider *John galloped the horse to the edge of the field.*) This example underscores the fact that traditional thematic role labels may be too coarse to express the relevant aspectual properties.

(25) Dutch:

a. Jan plant bomen in de tuin.
John plants trees in the garden.

b. Jan be-plant de tuin met bomen.
John be-plants the garden with trees.
(De Groot 1984, his source Dik 1980)

(26) Japanese:

a. kabe ni penki o nuru
wall on paint-ACC paint(VERB)
smear paint on the wall

b. kabe o penki de nuru
wall ACC paint-with paint(VERB)
smear the wall with paint
(Fukui, Miyagawa, Tenny 1985)

The locative alternation is an alternation in syntactic argument structure that depends on certain characteristics of the theme and the goal. Since we know syntax and semantics to be autonomous to such a large extent, we must ask why such seemingly trivial semantic properties should have syntactic repercussions such as these? The proposal that the direct internal argument is constrained to measure out the event described by the verb provides a simple explanation. These verbs describe exactly those events in which the goal may be construed as measuring out the event. If you apply some material to a flat surface, or fill a container with something, then the material spreads out across the surface or rises up to the top of the container in a consistent and uniform way, and in so doing may be seen to measure out the event.

The aspectual constraints on internal arguments predict certain other familiar facts about the locative alternation. Consider (27) below:

(27) a. spray the paint in the hole
b. spray the hole with paint

Phrase (27a) means that the paint is directed into the hole but not necessarily spread around on the surface or wall of the hole. (27b), however, is not an accurate paraphrase of (27a) because it means that the paint is spread around on the surface or wall of the hole. This is because when the goal, the hole, is the direct argument of the verb it is constrained to measure out the event.

The locative alternation is impossible when an instrument thematic role is substituted for the material thematic role. Both material and instrument are possible as indirect objects:

(28) a. spray the wall with water
b. spray the wall with a hose

But only the material can be a direct argument:

(29) a. spray water on the wall
b.*spray a hose on the wall

This is because a material is consumed a little at a time until it is gone, thus measuring out the event, but an instrument does not undergo change in such a way that it can be construed as measuring out the event. In this case it is precisely the aspectual properties of the material and instrument thematic roles which determine how they are mapped into the syntax.

Finally, this approach to the locative alternation can be extended to verbs that take "path" arguments. For example:

(30) a. walk the bridge
b. walk across the bridge
c. walk to the bridge

In (30a) *the bridge* is a path argument which measures out the event by virtue of being the verb's direct argument. Although both (30b) and (30c) are acceptable expressions, only (30b) may be a paraphrase of (30a). In (30a) and (30b) the walking event is understood to traverse the bridge, so that a certain amount of bridge correlates with a certain amount of walking. The bridge measures out the walking.

Under this view, it is the aspectual properties of thematic roles that are relevant for syntactic argument structure. The aspectual differences between materials and instruments, and the aspectual properties of certain types of goals, together with the principle that the internal argument measures out the event, are what make the locative alternation possible or impossible.[11]

2.5 Psych Verbs

Next consider psych verbs. These are verbs that have an argument bearing an experiencer thematic role. (The syntax of psych verbs has been discussed by Grimshaw (1987a), Pesetsky (1987), and Belletti and Rizzi (1988), among others.) In the sentences below, John is an experiencer. The experiencer is an external argument in (31a) and an internal argument in (31b):

(31) a. John fears ghosts.
b. Ghosts frighten John.

[11]The aspectual properties of thematic roles determine the possibility of the locative alternation as allowed by a universal semantics. Language-particular lexicalization may allow only a subset of these universal possibilities. We see this for example with *fill*:

(i) fill the cup
(ii)*fill the coffee

However, the prediction is that these "universal possibilities" allow *fill* to be re-analyzed as taking the locative alternation:

(iii)?fill the coffee up to the rim of the cup

Compare this with (23b)repeated below:

(iv)*push San Francisco with a cart

Psych verbs present interesting minimal pairs in which similar (or identical) verbs assign the same thematic role—experiencer—to the internal or external argument position. At first glance there seems to be no difference in meaning between the members of a pair like *fear* and *frighten*. However, there is an important difference in meaning between verbs with internal argument experiencers and external argument exeriencers, and this is the difference predicted by an aspectual theory of argument structure. When the experiencer is an internal argument it measures out the event, and when it is an external argument it does not.[12] This can be illustrated by adding delimiting expressions to the sentence:

(32) a.* *John*$_i$ feared the truth *into drinking*$_i$.
b. The truth frightened *John*$_i$ *into drinking*$_i$.

(33) a.??John feared *the truth*$_i$ *into innocuousness*$_i$.
b.* *The truth*$_i$ frightened John *into innocuousness*$_i$.

Sentence (33a) is problematic because *fear* is a stative verb, and the role of the internal argument as the measure of change is only apparent with verbs of change. (33a) is only acceptable if *fear* is interpreted (or perhaps re-analyzed) as a verb of change. If this is possible (and it may be for a very few speakers) then (33a) means "John made the truth innocuous by fearing it" or "John feared the truth so much it became innocuous for him." This re-analysis is easier with other experiencer-external psych verbs:

(34) a. John resented his neighbor so much, he resented him right into the hospital (by attacking him with a bat).
b. Mary admires her brother to pieces.

These expressions, facetious and idiomatic as they are, serve to illustrate that if these verbs can be understood as verbs of change, the universal aspectual structure of verbs of change—in which the internal argument measures out the event—is available. This aspectual structure is brought out by delimiting expressions that refer only to the internal argument. The delimiting expressions in (32), (33) and (34) (*into drinking*, *into innocuousness*, *into the hospital*, *to pieces*), are actually resultative secondary predicates. They refer to the central property of the internal argument which is changing and measuring out the event. They delimit the event by picking out some point in that ongoing change at which the event terminates. (The expression *to pieces* does so metaphorically if not literally.) When the experiencer is the external argument, the event may not be de-

[12]Belletti and Rizzi (1988) propose a structure for psych verbs with external argument experiencers in which both arguments are generated under the verb phrase, with the experiencer as the highest NP governed by the VP. This is not inconsistent with the theory proposed here since what is important is the correlation of aspectual and syntactic properties. If Belletti and Rizzi are correct, then it is the highest NP generated under the VP which measures out the event.

limited by referring to a property of that experiencer. When it is an internal argument, it is quite natural to do so.

The aspectual constraints on internal arguments provide an explanation for the familiar fact that secondary resultative predicates may refer to the object but not the subject of the sentence. Resultatives are syntactic constructions that depend on the aspectual structure built up by the composition of the verb and its direct argument. Since the external argument is excluded from this aspectual structure, resultatives may not be predicated of external arguments. Consistent with this is the fact that a resultative secondary predicate is constrained not just to refer to the object but to refer to the property of the object that is measuring out the event. The resultative and the internal argument must agree on what property that is. If the delimiting expression in (32b) is changed to a locational goal phrase, the sentence is bad unless it can be interpreted as expressing motion (i.e., change in location):

(35) The truth frightened John to Ohio.

Sentence (35) is incoherent if it is John's becoming afraid that measures out the event. But it is a good sentence if it is John's changing in location that measures out the event. In the latter case the sentence would be understood to mean that the truth made John go to Ohio by frightening him. Note that this view also unifies resultatives and goal phrases under one aspectual structure. It has been noted (by Simpson (1983), among others) that resultatives and goal phrases pattern together in many ways, and that they do not co-occur. This is not surprising given that they fulfill the same role in the aspectual structure of the sentence.

The case of these psych-verb pairs is particularly telling for a number of reasons. First of all, the thematic role of the arguments in internal and external position is exactly the same. (See Pesetsky 1987 for another view.) The aspectual difference between 'fear' and 'frighten' cannot be traced to differences in thematic structure. They derive only from the difference in syntactic structure.

Secondly, the object-orientation of resultatives is a syntactic fact of great generality. The connection of this fact with the aspectual properties of internal arguments underscores the idea that these properties are syntactically rather than thematically based. The tight connection between aspect and syntax suggests that we may expect to find further repercussions in syntax, of the aspectual properties of syntactic argument structure. And conversely, aspect may be used as a tool in syntactic investigations.

Finally, psych verbs have posed a problem for theories that tightly constrain the mapping of lexical semantics into syntax, because there seems to be no difference in meaning between comparable verbs with experiencers in internal and external argument position. However, there is a difference in meaning that follows from the different aspectual roles of the experiencer

in internal and external argument position. The thematic role of experiencer happens to be adaptable to either of the aspectual representations of internal or external argumenthood. In other words, the mapping of lexical semantics into syntax may be tightly constrained only if it is based on aspectual properties, rather than on thematic roles.

2.6 Other Verbs

Unaccusative verbs, locative alternation verbs, and psych verbs provide various kinds of evidence for the AIH. The aspectual properties of argument structure (and particularly of direct internal arguments) are easily apparent with these verbs. There are a few other classes of verbs in which this aspectual structure is less apparent. These include achievement verbs, verbs with goal agents, and verbs with source agents. These verbs may not argue for the AIH in a strong way, but they are not inconsistent with it.

Achievement verbs (e.g., *explode*, *die*) describe events that happen instantaneously (or nearly so). They have internal arguments which measure out the event, even though the measuring has no extended duration:

(36) The terrorist exploded the bomb.

It is not the duration of the measuring that is important; it is the fact that the internal argument registers the temporal end of the event. This is true in (36) since it is the bomb that undergoes the change that delimits the event, not the terrorist.

Verbs with goal agents (e.g., *acquire*, *buy*, *receive*) are another interesting class. Although the external argument, the agent, seems to be a kind of locational endpoint for the event, it is the internal argument that is actually measuring out the event over time. These verbs behave with rate adverbials in the same way as do unergatives:

(37) a. John acquired the property slowly, acquiring a little of it at a time.
b. John acquired the property slowly, *a little of him acquiring it at a time.

Verbs with source agents (e.g., *send*, *give*, *mail*) also describe events in which the external argument seems to mark a significant point of time in the event:

(38) Christopher sent the package to Bill.

Christopher's act of sending and the package's arrival at Bill's location both seem to mark a potential endpoint of the event. Nevertheless, it is the change undergone by the package and not by Christopher, which is referred to by the delimiting expression (the goal phrase, *to Bill*). In this respect, *send* is similar to *push*, discussed in Section 2.1.[13]

The discussion up to this point has focused on verbs that describe events

[13]Double object constructions based on these verbs pose interesting questions for the AIH which I will not address here. See Tenny 1987.

in which the internal argument undergoes some change or motion. It has been argued that with all of these verbs, the change or motion in the internal argument is such that it "measures out the event," or is a function of time. There are many verbs which are not statives, but which describe events in which the internal argument undergoes no change:

(39) a. George pounded the wall.
b. Mary embraced her sister.
c. Carla studied the elk population.

The internal arguments of the verbs above do not "measure out the event" in the sense described above. We can state the generalization about internal arguments of verbs of change as follows:

(40) The internal argument of a simple verb is constrained so that it either undergoes no change or motion in the event described by the verb, or it undergoes change or motion which "measures out the event."

Even with verbs where the internal argument undergoes no change or motion, the aspectual structure in which the internal argument measures out the event is sometimes latent. A resultative can be predicated only of the direct internal argument of a verb of contact. A direct internal argument (41a), but not an external argument (41b) or indirect internal argument (41c), can be forced to be understood as undergoing a change that delimits the event:

(41) a. George pounded the wall$_i$ to pieces$_i$.
b.*George$_i$ pounded the wall to exhaustion$_i$.
c.*George pounded on the wall$_i$ to pieces$_i$.

Thus the principle that internal arguments can measure out events has wider generality than what might at first appear to be the case. This suggest a bolder hypothesis as a corollary to (40):

(42) All verbs of change (simple nonstative verbs) have latent in them the aspectual structure in which an internal argument can measure out the event.

Principle (42) is proposed here as a direction for research. Whether this universal potential aspectual structure is instantiated or not likely depends on various language-particular conditions. Assuming modular principles of grammar, aspectual structure imposes its own constraints, which then interact with an assortment of other constraints, both in the core and the periphery of the grammar.

2.7 Summary

This section of the paper has argued that there is a strong correlation between aspectual properties and syntactic structures, which constrains the mapping of thematic roles into syntax. The aspect/syntax correlation centers on the verb's internal arguments. With verbs in which the internal

argument undergoes any change or motion, all and only direct internal arguments, or D-structural objects of the verb, measure out events. The event is delimited linguistically within the verb phrase, through reference to that "measuring out." These principles constitute the universal aspectual structure of verbs of change, or simple nonstative verbs. This aspectual structure is not always fully realized with all verbs of change, but it is latent in them and potentially realizable.

The correlation between aspectual properties and syntactic argument structure exerts some constraint on the mapping of lexical semantics into syntax, because only certain types of thematic roles are compatible with the requirement that they measure out an event. This theory amounts to a proposal for a certain kind of rigorous connection between lexical semantics, or verb meaning, and syntactic argument structure. However, under this view the essential autonomy of syntax and semantics is preserved, because they interact only through a restricted aspectual vocabulary.

The aspectual theory of argument structure introduces a fundamental semantic asymmetry paralleling the familiar syntactic asymmetry between subjects and objects, or between external and internal arguments. In a sense, this is a rather conservative proposal.

Finally, it must be noted that this aspectual theory of argument structure introduces an unusual view of aspect. Aspectual properties have usually been associated with predicates and predicative expressions, such as verbs, verb phrases, or clauses. But with this approach, we can also talk about the aspectual properties that arguments and noun phrases receive from their governing predicates.

3 The AIH and Thematic Roles

This paper argues for the existence of an aspectual interface between thematic structure and syntactic structure. Under this view, thematic roles are not directly visible to syntactic structure. This does not mean that thematic roles do not exist, or do not need to be characterized in some fashion. What implications does the AIH have for the nature of thematic roles?

The idea that it is the compatibility of various thematic roles with certain aspectual constraints that governs their mapping into syntactic argument positions imparts a view of thematic roles like that propounded in Dowty 1991. Dowty argues that linguistic theory needs to recognize two proto-roles, a Proto-Agent and a Proto-Patient, instead of a set of discrete thematic roles; and these proto-roles are "higher order generalizations about meanings" (Dowty 1991). Associated with these proto-roles are collections of agent-like and patient-like characteristics which are the criteria by which argument selection takes place (from Dowty 1991):

Argument Selection Principle: The argument of a predicate having the greatest number of Proto-Agent properties entailed by the meaning

of the predicate will, all else being equal, be lexicalized as the subject of the predicate; the argument having the greatest number of Proto-Patient properties will, all else being equal, be lexicalized as the direct object of the predicate.

Corollary 1: If two arguments of a relation have (approximately) equal numbers of entailed Proto-agent and Proto-patient properties, then either may be lexicalized as the subject (and similarly for objects).

Under this approach thematic roles are essentially generalizations about elements of meaning which map to internal or external argument positions. This view of thematic roles is highly compatible with the AIH.

Dowty lists the properties which contribute to Proto-Agent and Proto-Patient roles as:

Contributing Properties for the Agent Proto-Role:

a. volition
b. sentience
c. cause event
d. movement
(e. referent exists independent of action of verb)

Contributing Properties for the Patient Proto-Role:

a. change of state (including coming-to-being, going-out-of-being)
b. incremental theme (i.e., determinant of aspect)
c. causally affected by event
d. stationary (relative to movement of Proto-Agent)
(e. referent may not exist independent of action of verb, or may not exist at all)

These properties are aligned according to whether or not they can "measure out" the event." The Proto-Patient properties are conducive to doing this; the Proto-Agent properties are not. The AIH unifies changes of state, affected theme and incremental theme verbs under one system. In fact, the AIH derives the distinction between Proto-Agent and Proto-Patient roles, which otherwise is unmotivated. Dowty's theory of thematic roles is not only compatible with the AIH, it is motivated by it.

4 Implications for Language Acquisition

The claim that predicates of natural language characterize events in a very particular and constrained fashion has implications for cognitive science in general, and for language acquisition in particular. I will close with some brief speculations about issues relating to language acquisition.

The Aspectual Interface Hypothesis has three specific consequences for language acquisition; it underscores the necessity of syntactic information

in the acquisition of verbs, it predicts certain interactions between cognitive and linguistic development, and it makes predictions about what are impossible verbs.

The importance of syntactic information to verb meanings is reflected in the practice of many linguists, of including within the lexical entry of a verb some indication of how the verb's arguments are to be realized syntactically. Because the syntactic information cannot be derived from the core (pre-aspectual) meaning of a verb by any perfect mapping, it must be independent information that has to be acquired and listed in the lexicon. Among researchers on language acquisition, the claim has been made that syntactic information is necessary for verb acquisition. The claim has been made in its general form by Landau and Gleitman (1985) and as a more particular thesis by Gropen, Pinker, and Goldberg (1987). Gropen et al. report on experiments which indicate that children rely on a principle which associates affectedness (an aspectual property) with direct object-hood (a syntactic property), in learning the meanings of the locative alternation verbs.

The importance of the acquisition of syntactic information does not preclude the need for acquiring conceptual information or machinery as well. The AIH predicts that cognitive development will enter into language acquisition in very particular ways. The AIH constrains to some extent the interaction of children's cognitive growth with their linguistic capabilities. Children's understanding of the nature of events and change, and particularly their ability to recognize properties that "measure out events" should affect the difficulty with which they learn various predicates.

A theory proposing a correlation between aspectual and syntactic structure makes strong predictions about possible and impossible verbs. If the view advanced in this paper is correct, verbs that violate the aspectual constraints on argument structure should be impossible verbs. They should not be found in any language, and they should be impossible for children to learn through normal processes of language acquisition. In the next few paragraphs a few "impossible verbs" are described which violate aspectual principles of argument structure.

Verbs with two or more direct internal arguments: Verbs of change describe events measurable on a single scale, which can only be associated with a direct internal argument. A verb with two or more direct internal arguments, both measuring out the event, would violate this principle. Such a verb would describe an event measured out on two independent scales. An example would be a verb meaning "A melts and B freezes," such that the melting of A and the freezing of B *independently* define or measure out the event. This event comes to an end when A has melted and B has frozen. Such a meaning is expressible through conjunction, although it cannot be lexicalized in a single verb. Note that a verb meaning "A melts and freezes" would be a possible verb. The scale on which this event

is measured out would be a little peculiar to characterize, but it would be a single scale.

Verbs with two or more delimiting oblique arguments: An event described by a verb may be delimited only once. A verb with more than one delimiting argument would violate this principle. This would be a verb taking two or more arguments indicating endpoints to the event—for example, two or more goal arguments. Such a verb would be used as follows: *Push the cart to San Francisco to Mexico*, meaning push the cart to San Francisco and to Mexico. Again, the constraint on this structure is not pragmatic because the meaning can be expressed through conjunction.

Verbs with no internal arguments (including implicit or default arguments): If all verbs of change describe events measurable on some scale, then all verbs of change have potential internal arguments. A verb violating this principle would be a verb which indicates no scale on which the event is measured out. There are many verbs which occur with an external argument and without an overt internal argument, but these verbs can generally take some kind of internal argument such as a cognate object or a reflexive. However, the impossible verb being invented here would have no way of taking any internal argument or direct object. There is a strong claim here; that there may be verbs that can never take external arguments but there are no verbs that can never take internal arguments (including cognate objects and reflexives). This claim may be too strong, but the prediction would be that where default internal arguments are impossible, it is because of stylistic, pragmatic or other extragrammatical or language-particular considerations.

Verbs with two or more external arguments: Although the AIH provides no explanation of why a verb can only have one external argument, it does characterize external arguments aspectually. A verb taking two or more external arguments has not been attested, as far as I know. If there were such a verb it would be a verb which takes two arguments, neither of which measures out the event, or participates in the internal aspectual structure of the event. An example would be a verb that means "some indefinite or incompletely specified change is happening with argument *A and* some indefinite or incompletely specified change is happening with argument *B*." This verb would have as part of its meaning a notion similar to "while." An example would be a verb with arguments *A* and *B*, meaning:

A scratches and *B* dances
A sings while *B* jumps

This does not rule out a verb that means something like "*A* makes *B* dance by scratching," in which case *B*'s traversal of the dance event *is* measuring out the event; and the scratching belongs in a manner clause, without aspectual constraints. (*Dance Bill up the stairs (by scratching).*) (This

is putting aside the special properties of syntactic causative constructions, which are not lexicalized events.)

A verb describing an event in which one argument measures out the event and the other does not is always possible, even if the change or activity of the external argument is seemingly unrelated to the measuring-out change. A verb meaning something like "*A* scratches and *B* gets wetter" is in principle a possible verb, if one of the arguments has the properties of an external argument, and the other of an internal argument. It is only necessary for such a concept to be useful to the speakers of the language for such a verb to be created. Such a verb might mean something like "*A* scratchingly wets *B*."

Several kinds of aspectually "impossible verbs" have been imagined and described above. This kind of prediction about possible or impossible verbs may be testable in language acquisition experiments. I know of no experimental work that sheds light on them, and the appropriate tests may be difficult to design. Nevertheless, the aspectual properties of argument structure introduced by the AIH do make strong, and in principle falsifiable, predictions for natural language acquisition.

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