

# A Computational Model of Tense, Voice & Aspect

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## Abstract

This paper considers the treatment of the English inflectional verb features: 1) tense, 2) voice, and 3) aspect, within a computational model of human language comprehension grounded in linguistic and psycholinguistic theory. Verbs, including auxiliary and modal verbs, are inflectionally encoded with tense, aspect and voice features and these features can project to, or be expressed by, the clauses in which they occur. When there are multiple verbal elements in a clause, the grammatical features of the verbal elements must be reconciled. Monotonic unification of grammatical features is not possible when the grammatical features of the verbal elements conflict. Non-monotonic mechanisms of feature blocking and overriding are needed to handle the reconciling of incompatible features.

## 1. Introduction

This paper considers the treatment of the English inflectional verb features: 1) tense, 2) voice, and 3) aspect, within a computational model of human language comprehension grounded in linguistic and psycholinguistic theory.

From a processing perspective, a key goal is to minimize the amount of ambiguity in support of an incremental, pseudo-deterministic human language processor (Ball, submitted a). At the processing of each word, the incremental, pseudo-deterministic processor uses all available information in parallel to make representational choices that are assumed to be correct. Once a commitment to a representational choice is made, the processor proceeds serially and deterministically forward until the next choice point. A non-monotonic mechanism of context accommodation—which supports the blocking and overriding of grammatical features—allows for modest adjustment of the evolving representation. Overall, the processor is pseudo-deterministic in that it presents the appearance and efficiency of a deterministic processor, but uses information in parallel at each choice point and allows for non-monotonic adjustment of the evolving representation.

From a representational perspective, which is the primary focus of this paper, we start with the analysis of Ball (2007) which provides an overview of the basic structure and function of nominals and clauses in English. Ball (submitted b) extends that analysis to a consideration of the grammatical features of nominals. This paper extends the analysis to a consideration of inflectional verb features. Ball (2007) espouses a bi-polar theory of nominal and clause structure which is an adaptation of X-Bar Theory (Chomsky, 1970). In Bi-Polar Theory, nominals and clauses contain two primary functional elements: 1) a specifier, which is the locus for encoding referential meaning, and 2) a head, which is the locus for encoding relational meaning. These two functional elements combine to form a complete nominal or clause. Normally these functional elements are expressed by different words or phrases. For example, a nominal typically consists of a determiner like “the” functioning as specifier and a noun like “pilot” functioning as head, as

in “the pilot”. Likewise, in “he is laughing”, the auxiliary verb “is” functions as specifier and the main verb “laughing” functions as head. However, in “he laughed”, the specifier and head functions are combined together within the tensed verb “laughed”. Bi-Polar Theory eschews the basic notion of endocentricity (Bloomfield, 1933) wherein the head of a phrase necessarily and exclusively determines the nature of the phrase. Both the specifier and the head make important contributions to the projected phrase. Since the specifier occurs before the head in English, and we assume an incremental processor, the specifier and not the head, typically projects the higher level phrasal unit. For example, the auxiliary verb “is” in “he is laughing” projects the clausal structure, not the main verb “laughing”. This has led some to suggest that the specifier is a head as reflected in the functional head hypothesis (cf. Abney, 1987). We reject this hypothesis and instead weaken the notion of endocentricity in allowing the specifier as well as the head to determine the basic nature of phrases. Cann (1999) adopts a similar position, calling the specifier a secondary head. We do not use the term secondary head.

It is a basic assumption of Bi-Polar Theory that clauses refer to situations, just as nominals refer to objects. In clauses, tense is the primary indicator of referential meaning, and the main verb is the primary indicator of relational meaning. Whereas referential meaning is grammaticalized via verbal inflection for tense, and to some extent aspect, relational meaning is lexicalized, but subject to grammaticalization via inflection for voice (i.e. the contrast between *active* and *passive* voice). Relational lexical items are associated with one or more complements which express the arguments of the relation. In the case of transitive verbs, passivization results in demotion of the active subject to an optional oblique complement and promotion of the object (or indirect object) to the subject function. In the case of intransitive verbs, passivization results in demotion of the active status of the subject to that of passive participant. We reserve the term complement to describe relational arguments. Introduction of the functional head hypothesis has led to an expanded use of this term. For example, if “is” is treated as a functional head in “he is laughing”, then “laughing” is typically treated as a complement of “is”. On the other hand, if “is” is a specifier and “laughing” is the head, then the only complement in this intransitive construction is the subject. We adopt the approach of treating the auxiliary verb as a specifier and the main verb as a head, aligning with Culicover & Jackendoff (2005) in treating the main verb as the head of the clause.

Within the context of Bi-Polar Theory, the detailed representational commitments made in this paper are primarily informed by the analysis of Huddleston & Pullum (2002) and Quirk et al. (1985). Huddleston & Pullum (2002) argue against the rampant redundancy and ambiguity of traditional grammatical treatments which espouse a large degree of syncretism (i.e. the same verb form having multiple grammatical functions). This paper pushes their arguments even further, but does not eliminate all ambiguity. For example, English collapses (or syncretizes) the distinction between the *past tense* and the *past participle* in verbs which do not have a distinct *past participle* form as in

1. The horse kicked the man
2. The horse has kicked the man

In 1, “kicked” is used as a *past tense* verb, whereas in 2, “kicked” is used as the *past participle*. This distinction is clear in verbs which have distinct forms as in

3. The man gave me the book
4. The man has given me the book

In 3, “gave” is the *past tense* and in 4 “given” is the *past participle*.

English has a highly restricted number of distinct verb forms which include the following:

- V-bare (or V-plain) verb (e.g. “give”)
- V-s form (e.g. “gives”)
- V-ed form (e.g. “gave”, “kicked”)
- V-en form (e.g. “given”, “gone”)
- V-ing form (e.g. “giving”)

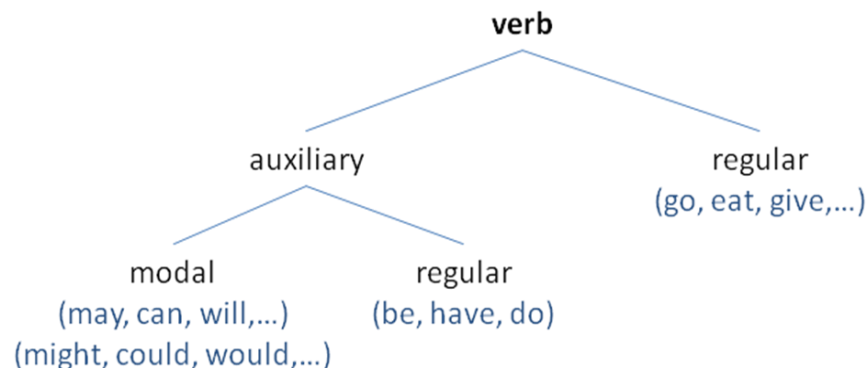
“Gave” is an irregular v-ed form and “gone” is an irregular v-en form. The analysis of Quirk et al. (1985) differs slightly in that they treat the v-en form as an irregular v-ed form and only acknowledge four different forms. We also treat the combination of the infinitive marker “to” and the bare verb form as a distinct verb form, abbreviated as to+v-bare. Since our model is capable of recognizing multi-word units, the infinitive form can be recognized as distinct from the v-bare form. In total, we claim the existence of six different verb forms.

We make a distinction between *primary uses* of verbs, which reflect the verb specific encoding and expression of grammatical features, and *secondary uses* in which it is not the verb, but the encompassing construction or pragmatic inferences operating over the construction, which determines the use. There is no grammatical marking on verbs for secondary uses. In contrast to our distinction between primary and secondary uses, Huddleston & Pullum (2002) argue for a distinction between grammatical concepts and semantic concepts. For example, they distinguish “tense” as a grammatical concept from “time” as a semantic concept. *Present tense*, a grammatical concept, is typically used to express present events, but can also be used to express future events (e.g. “he goes tomorrow”), where present and future events are semantic concepts. We argue instead that *present tense* verbs encode and can express *present tense* as their primary use, but they have a secondary use in which they can function in the description of future events. Much of the analysis of Huddleston & Pullum (2002) is concerned with what we term secondary uses. We do not attempt in this paper to grapple with the wide range of secondary uses which are not grammatically marked on specific verbs. Dealing with secondary uses will require extension of the mechanisms of blocking and overriding beyond their use in explaining the encoding and expression of grammatical features within and across verbal elements.

There are two primary goals for this paper: 1) identify the tense, voice and aspect features that go with the different verb forms of the different verb types (see below), and 2) show how the features project in the various combinations of verb types that occur in English.

## 2. Verb Types

In English, there are three primary verb types:



We distinguish auxiliary verbs from regular verbs and within the auxiliary verbs we distinguish modal auxiliaries from regular auxiliaries. Huddleston & Pullum (2002) and

Quirk et al. (1985) provide multiple grammatical criteria for distinguishing between these verb classes, although they use slightly different terminology (e.g. Quirk et al. call regular auxiliaries “primary verbs” and regular verbs “secondary verbs”). As we will see below, there are differences in the encoding of tense, voice and aspect across the different types of verbs in their various forms. There are also minor verb categories (e.g. semi-auxiliary) and atypical members of the primary categories (e.g. the modal auxiliary “ought”) which will not be discussed in this paper.

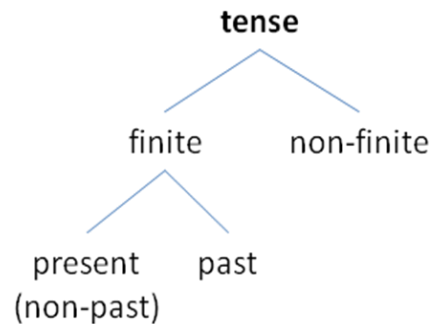
The modal auxiliaries differ from regular auxiliaries and regular verbs in having a single v-bare verb form.

### 3. Individual Encoding and Expression of Tense, Voice and Aspect

This section considers the encoding of tense, voice and aspect on the different forms of individual verbal elements of the three main types. We claim that all verb types inflectionally encode the grammatical feature tense, that regular auxiliaries and regular verbs also encode aspect, and that at least one verbal element in a clause encodes for voice. The features encoded by verbal elements may or may not project to, or be expressed by, the clauses in which they occur.

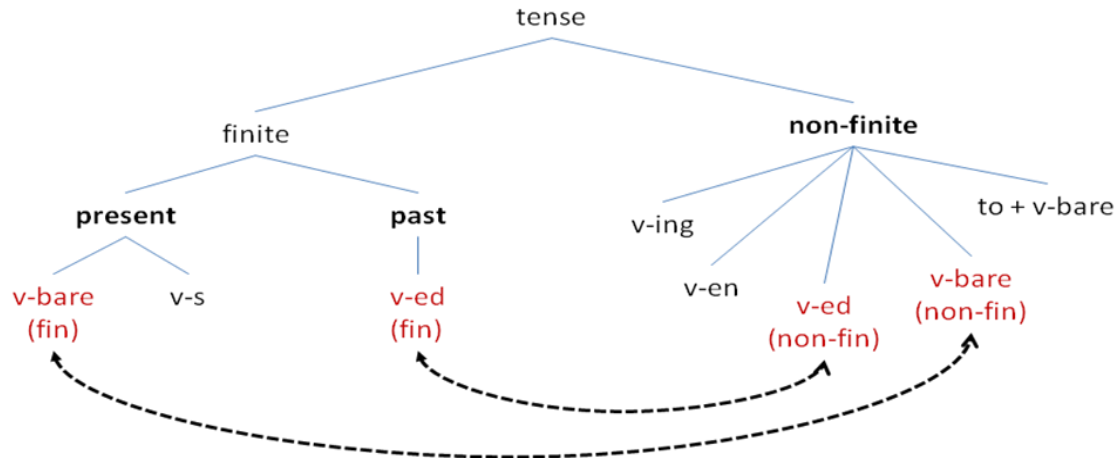
#### 3.1 Tense

In the case of tense, we assume the following ontology:



There is no inflectional marking for *future tense* in English. The *present tense* (e.g. “I go to London tomorrow”) and the modal auxiliaries—especially “will” (e.g. “I will go tomorrow”)—are co-opted to express future events. Although we will use the term *present tense*, *non-past* is an alternative term which better reflects the primary uses of *present tense*. In the section on modality, we explore the contrast between *past* and *non-past* uses of modal auxiliaries, and we consider the possibility that “will” lexically encodes a *future tense* feature. *Non-finite* corresponds to the lack of tense.

We claim that all three verb types encode for tense, except for non-finite forms. In terms of the mapping from different verb forms to the tense feature, we have the following:



There are eight tense differentiated verb categories corresponding to the six different verb forms. The *v*-bare and *v*-ed forms are ambiguous with respect to tense. The *v*-bare form (e.g. “go”) corresponds to the plain form of Huddleston & Pullum (2002)—except that we introduce a special infinitive form, *to*+*v*-bare, that is distinct from the *v*-bare form. Having a distinct infinitive form (e.g. “to go”) allows the model to unambiguously recognize infinitives as multi-word units and reduces the overall ambiguity. The remaining ambiguity can be resolved by assuming a default tense preference which can be overridden in the appropriate context. The default *v*-bare preference is finite *present tense*. In the absence of a context that cues a non-default tense, this tense is assumed. Declarative (e.g. “I go”), imperative (e.g. “Go now!”) and subjunctive expressions (e.g. “I demand that he go”) express finite *present tense* via the default preference. We align with Quirk et al. (1985) in this respect. The infinitive of the *v*-bare form is marked by the occurrence of “to” (e.g. “to go”). The other *non-finite* tenses are either marked by a modal auxiliary (e.g. “he could go”), the auxiliary verb “do” (e.g. “he did go”) or special verb constructions (e.g. “He made me go”).

The *v*-ed verb form is also ambiguous with respect to tense. In the case of transitive verbs, the default preference is *non-finite*. For example, in

5. Kicked by the horse, he limped

there is no context to bias “kicked”, and it encodes and expresses the default *non-finite* preference. On the other hand, in

6. The horse kicked the fence

where “kicked” is preceded by the subject, it encodes and projects finite *past tense*. The subject context is sufficient to bias “kicked” to the *past tense* reading. In

7. The horse has kicked the fence
8. The fence was kicked by the horse

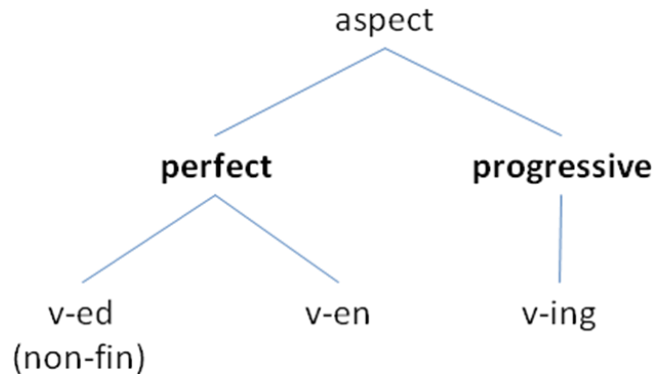
“kicked” is again *non-finite*. Note that in 7, “kicked” encodes and expresses *perfect aspect* (discussed below), not *past tense*, and in 5 and 8, “kicked” encodes and expresses *passive voice* (discussed below), not *past tense*.

Modal auxiliaries and the regular auxiliary “do” differ from the regular auxiliaries “be” and “have”, and regular verbs in only encoding *finite* tense. Both Quirk et al. (1985) and Huddleston & Pullum (2002) argue that modal auxiliaries have both a *v*-bare *present tense* form (e.g. “may”,

“can”, “will”) and an irregular v-ed *past tense* form (e.g. “might”, “could”, “would”). There are problems with the *past tense* analysis which are discussed in the section on modal auxiliaries.

### 3.2 Aspect

For aspect, we assume the following ontology:



We categorize *perfect* as a type of aspect, agreeing with the analysis of Quirk et al. (1985). Although *perfect* clearly overlaps the *past tense* in meaning—leading Huddleston & Pullum to treat it as a type of tense—it also has an aspectual nature—in the sense of completing an action (before or up to the time of utterance). We refer to *perfect aspect* as “past-completion” with “completion” heading the complex noun and emphasizing its aspectual dimension of meaning relative to “past” which functions as a modifier. Grammatically, there is a clear contrast in form between *progressive* and *perfect aspect* in English with the v-ing verb form corresponding to the *progressive* and the v-en or v-ed verb form corresponding to the *perfect*. For example, consider

9. He is going
10. He has gone

In 9, “going” is *progressive* and in 10, “gone” (an irregular v-en form) is *perfect*. It is traditional to assume that the *progressive* is marked by the combination of “be” with the v-ing verb form and that the *perfect* is marked by the combination of “have” with the v-en or v-ed (non-finite) verb form. However, both “going” and “gone” can occur without “be” or “have” as in

11. Going to the movies is fun
12. Gone in sixty seconds

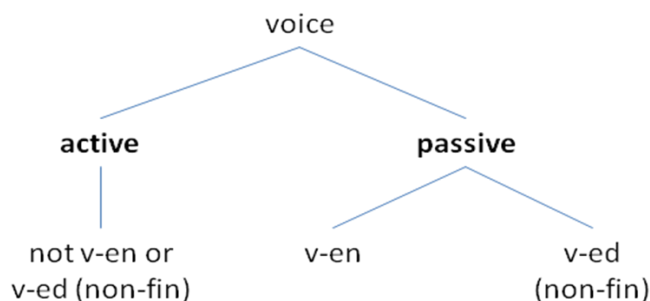
In 11, “going” is clearly *progressive* and in 12, “gone” has a distinct *perfect* (i.e. past-completion) feel.

In this paper, we argue that v-en and *non-finite* v-ed verbs encode and have the potential to project both *perfect aspect* and *passive voice*. When the v-en form is preceded by “have”, projection of *passive voice* is suppressed. When the v-en form is preceded by “is” or occurs in isolation, *passive voice* is projected and there is variability in the projection of *perfect aspect*.

We claim that only regular verbs encode an aspect feature. In particular, “have” does not encode *perfect aspect*. Instead, as argued below, “have” encodes *active voice* which is incompatible with expression of *passive voice* by the immediately following regular verb.

### 3.3 Voice

For voice, we assume the following ontology:



In contrast to most other approaches, we assume that voice is a grammatical feature of intransitive as well as transitive verbs. In the case of intransitive verbs, *passive voice* results in demotion of the active subject to the status of passive participant. In the case of transitive verbs, passivization results in demotion of the active subject to an optional oblique complement and promotion of the object (or indirect object) to the subject function.

We assume that clausal expression of voice is lexicalized and that at least one verbal element in a clause encodes and expresses voice—either *active* or *passive*. Typically, this is the regular verb which is the final verbal element. However, other verbal elements may encode and express voice. In particular, the regular auxiliaries “have” and “do” encode and express *active voice*, whereas the regular auxiliary “be” does not encode voice—either *active* or *passive*. The encoding of *active voice* by “do” and “have” has important consequences across verbal elements (discussed in the next section). The assumption that at least one verbal element in a clause encodes and expresses voice suggests that modal auxiliaries may be capable of doing so. Consider the expression “he will give me the ball”. In this expression either the modal auxiliary “will” encodes and expresses *active voice* or the bare verb “give” does, or both.

#### 4. Combining Features across Verbal Elements

In this section, we consider the combining of tense, voice and aspect across the verbal elements in a clause within the context of a computational model of human language processing. We first present sample entries for a collection of verbs and auxiliary verbs and then show how these entries combine across verbal elements. A key assumption is that the features of verbal elements may conflict, necessitating non-monotonic mechanisms for blocking and overriding of features, and prohibiting monotonic unification as the primary integration mechanism. Competing computational approaches posit multiple verbal entries with different sets of grammatical features, constraint-based mechanisms which select compatible entries, and monotonic unification as the basic feature integration mechanism. Such approaches are incompatible with an incremental, pseudo-deterministic human language processor. They introduce too much representational ambiguity, require more parallelism than can be accommodated, and necessitate more structure building than is supportable within the constraints of an incremental, pseudo-deterministic human language processor (see Ball submitted a, for discussion).

With respect to feature blocking, we assume that the grammatical features of the first of two immediately adjacent verbal elements suppress expression of conflicting grammatical features of the second. For example, a verbal element expressing *active voice* is incompatible with an immediately following verbal element expressing *passive voice*—e.g., expression of *active voice* by “has” suppresses expression of *passive voice* by “kicked” in “he has kicked the ball”. However, this only applies to the immediately following verbal element. With respect to feature overriding, if there is an intervening verbal element which allows expression of a feature, then this feature can be expressed and can override a conflicting feature beyond the immediately

preceding verbal element. For example, the *passive voice* of “kicked” can be expressed and can override the *active voice* of “has” in “the ball has been kicked” since “been” does not project voice, and this allows “kicked” to express *passive voice* and to override the *active voice* of “has”. An alternative view is that “been” unsets the *active voice* of “has” allowing the *passive voice* of “kicked” to project. It may be that “been” is quite special in this respect—note that “been” is the irregular v-en form of “be” which occurs exclusively following “have”, and v-en forms normally encode *passive voice*. Non-monotonic feature blocking and overriding are the most distinctive elements of the approach presented in this paper.

In this section, we show relevant elements of the computational representation of verbs. To simplify the representations, we use the following abbreviations:

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pres = present
act = active
pass = passive
perf = perfect
ditrans = ditransitive
trans = transitive
intrans = intransitive
aux = auxiliary verb
reg = regular (auxiliary verb)
modal = modal auxiliary verb
fin = finite
non-fin = non-finite

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As an example, consider the representation of the ditransitive verb “give” (ditransitive is a subtype of *transitive verb*). There are seven entries in the mental lexicon associated with the verb “give”.

Give isa verb	Gives isa verb	Gave isa verb
Type ditrans	Type ditrans	Type ditrans
Form v-bare	Form v-s	Form v-ed
Base give	Base give	Base give
Tense' fin	Tense' fin	Tense' fin
Tense pres	Tense pres	Tense past
Voice act	Voice act	Voice act
Aspect “none”	Aspect “none”	Aspect “none”
Give-2 isa verb	To-give isa verb	
Type ditrans	Type ditrans	
Form v-bare	Form to+v-bare	
Base give	Base give	
Tense' non-fin	Tense' non-fin	
Tense “none”	Tense “none”	
Voice act	Voice act	
Aspect “none”	Aspect “none”	
Giving isa verb	Given isa verb	
Type ditrans	Type ditrans	
Form v-ing	Form v-en	
Base give	Base give	
Tense' non-fin	Tense' non-fin	
Tense “none”	Tense “none”	
Voice act	Voice pass	
Aspect prog	Aspect perf	

“Give” has two *present* tense forms, one *past* tense form and four *non-finite* forms (tense “none”). The *present* tense and *past* tense forms are all *active voice* and are unmarked for aspect (i.e.



aspect “none”). Of the *non-finite* forms, “give”, “to-give” and “giving” are *active* voice, whereas “given” is *passive* voice. “Giving” is *progressive* aspect and “given” is *perfect* aspect, whereas “give” (non-fin) and “to give” do not encode aspect. The fact that the different forms of “give” encode the specified features, does not mean that these features project to, or are expressed by, the clauses in which they occur. Projection depends on the context in which the verb occurs and features may be suppressed or unexpressed in particular contexts, and overridden in other contexts.

Note the assumption that there are seven separate entries in the mental lexicon corresponding to “give”. We assume that for commonly occurring verbs like “give” all the different forms and tense variations are separately encoded. These forms and tense variations have been experienced frequently enough to be separately represented in the mental lexicon. In this paper, we do not discuss the productive generation of verb forms for less common verbs.

As an example of an intransitive verb with distinct v-ed (finite) and v-en forms, consider “go” for which only the v-ed (finite) and v-en forms are shown:

Went isa verb	Gone isa verb
Type intrans	Type intrans
Form v-ed	Form v-en
Base go	Base go
Tense' fin	Tense' non-fin
Tense past	Tense “none”
Voice act	Voice pass
Aspect “none”	Aspect perf

Note that intransitive verbs encode a voice feature. In the case of “went” and “gone”, “went” is *active* and “gone” is *passive*. “Went”, the irregular v-ed form, is *past* tense and “gone”, the irregular v-en form, is *perfect* aspect.

As an example of a transitive verb with a tense ambiguous v-ed form, consider “kicked”:

Kicked-1 isa verb	Kicked-2 isa verb
Type trans	Type trans
Form v-ed	Form v-ed
Base kick	Base kick
Tense fin'	Tense' non-fin
Tense past	Tense “none”
Voice act	Voice pass
Aspect “none”	Aspect perf

There are two entries for the v-ed form, one that is finite and encodes *past* tense and *active* voice, and one that is *non-finite* (tense “none”) and encodes *passive* voice and *perfect* aspect.

Finally, as an example of an intransitive verb with a tense ambiguous v-ed form, consider “cried”:

Cried-1 isa verb	Cried-2 isa verb
Type intrans	Type intrans
Form v-ed	Form v-ed
Base cry	Base cry
Tense' fin	Tense' non-fin
Tense past	Tense "none"
Voice act	Voice pass
Aspect "none"	Aspect perf

Like the transitive verb “kicked”, the first entry is finite *past* tense and *active* voice, and the second entry is *non-finite*, *perfect* aspect and *passive* voice. According to Huddleston & Pullum (2002, p. 78) “we take the perfect and passive construction to involve different uses of the same inflectional form”. In our approach, we encode this within a single entry in the mental lexicon marked for both grammatical features, rather than having two separate entries.

As these examples show, a single verb cannot be at once *past* tense and *perfect* aspect, or *past* tense and *passive* voice. However, auxiliary verbs combine with main verbs to form more complex verb groups, including verb groups which express both *past* tense and *perfect* aspect, and both *past* tense and *passive* voice.

The primary regular auxiliaries are “be”, “have” and “do”. Sample entries in the mental lexicon are shown below:

Be isa aux	Is isa aux	Was isa aux
Type reg	Type reg	Type reg
Form v-bare	Form v-s	Form v-ed
Base be	Base be	Base be
Tense' fin	Tense' fin	Tense' fin
Tense pres	Tense pres	Tense past
Voice "none"	Voice "none"	Voice "none"
Aspect "none"	Aspect "none"	Aspect "none"

Be-2 isa aux	To-be isa aux
Type reg	Type reg
Form v-bare	Form to+v-bare
Base be	Base be
Tense' non-fin	Tense' non-fin
Tense "none"	Tense "none"
Voice "none"	Voice "none"
Aspect "none"	Aspect "none"

Being isa aux	Been isa aux
Type reg	Type reg
Form v-ing	Form v-en
Base be	Base be
Tense' non-fin	Tense' non-fin
Tense "none"	Tense "none"
Voice "none"	Voice pass
Aspect prog	Aspect perf

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Have isa aux	Has isa aux	Had isa aux
Type reg	Type reg	Type reg
Form v-bare	Form v-s	Form v-ed
Base have	Base have	Base have
Tense' fin	Tense' fin	Tense' fin
Tense pres	Tense pres	Tense past
Voice act	Voice act	Voice act
Aspect "none"	Aspect "none"	Aspect "none"

Have-2 isa aux	To-have isa aux
Type reg	Type reg
Form v-bare	Form to+v-bare
Base have	Base have
Tense' non-fin	Tense' non-fin
Tense "none"	Tense "none"
Voice act	Voice act
Aspect "none"	Aspect "none"

Having isa aux	<del>Had-2 isa aux</del>
Type reg	<del>Type reg</del>
Form v-ing	<del>Form v-ed-or-en</del>
Base have	<del>Base have</del>
Tense' non-fin	<del>Tense' non-fin</del>
Tense "none"	<del>Tense "none"</del>
Voice act	<del>Voice pass</del>
Aspect prog	<del>Aspect perf</del>

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Do isa aux	Does isa aux	Did isa aux
Type reg	Type reg	Type reg
Form v-bare	Form v-s	Form v-ed-or-en
Base do	Base do	Base do
Tense' fin	Tense' fin	Tense' fin
Tense pres	Tense pres	Tense past
Voice act	Voice act	Voice act
Aspect "none"	Aspect "none"	Aspect "none"

<del>Do-2 isa aux</del>
<del>Type reg</del>
<del>Form v-bare</del>
<del>Base do</del>
<del>Tense' non-fin</del>
<del>Tense</del>
<del>Voice act</del>
<del>Aspect</del>

<del>To-do isa aux</del>
<del>Type reg</del>
<del>Form to+v-bare</del>
<del>Base do</del>
<del>Tense' non-fin</del>
<del>Tense "none"</del>
<del>Voice act</del>
<del>Aspect "none"</del>

<del>Doing isa aux</del>
<del>Type reg</del>
<del>Form v-ing</del>
<del>Base do</del>
<del>Tense' non-fin</del>
<del>Tense "none"</del>
<del>Voice act</del>
<del>Aspect prog</del>

<del>Done isa aux</del>
<del>Type reg</del>
<del>Form v-ed-or-en</del>
<del>Base do</del>
<del>Tense' non-fin</del>
<del>Tense "none"</del>
<del>Voice pass</del>
<del>Aspect perf</del>

Not shown are the 1<sup>st</sup> and 2<sup>nd</sup> person (and 3<sup>rd</sup> person plural) forms of “be” (i.e. “am” and “are”) which pattern like “is”. Also not shown is the *past* tense plural form “were” which patterns like the *past* tense singular form “was”. Note the assumption that the tensed forms of “be” do not encode for voice, whereas the tensed forms of “have” and “do” do, with both being *active* voice. It is unclear if two auxiliary verb entries for “had” are needed. We assume that only a single finite v-ed form is needed. Quirk et al. (1985) make a similar claim. “Having” appears to be limited to use as an auxiliary verb in non-finite clauses like “Having tried his best, he was satisfied”. In finite clauses, it functions exclusively as a transitive verb (e.g. “he is having a good time”). The non-finite forms of “do” do not function as auxiliary verbs. They have a strictly transitive verb function (see the section on transitive verb uses of “do” and “have”). Quirk et al. (1985) make a similar claim. Although we show “been” as encoding *passive* voice, since it always occurs in the context of “have” which expresses *active* voice, the *passive* voice of “been” never projects to the

clause. Very rare exceptions include expressions like “Been there, done that”. It does not seem that “been” expresses *passive* voice in this expression and there may be an implicit “have” as in “I’ve been there and done that”.

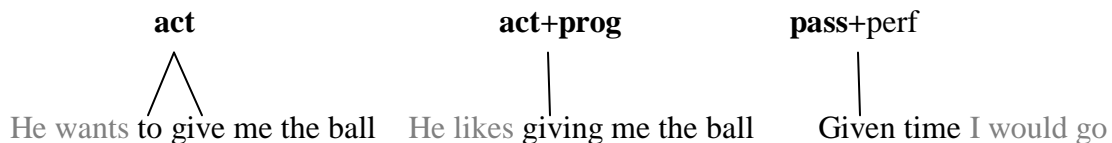
#### 4.1 Verb Feature Projection for “Give”

This section considers the encoding and projection of features in clauses containing “give” as the main verb. First we consider clauses with a single main verb, starting with *present* and *past* tense “give”.



In the first clause, “gives” encodes and projects the *present* tense and the *active* voice features. In the second clause, “gave” encodes and projects the *past* tense and *active* voice features. Since there are no other verbal elements in these clauses, “gives” and “gave” are the only elements that project features, but we will see more complex examples below.

We next consider the non-finite forms of “give”:



In the first example, since “to give” is the only verbal element in the subordinate clause, we assume that “to give” encodes and projects *active* voice. In the second example, “giving” encodes and projects *active* voice and *progressive* aspect. In the third example, “given” encodes and projects *passive* voice and *perfect* aspect. Of these, the claim that “to give” and “given” project *active* voice, and “given” projects *perfect* aspect are least supportable.

With respect to voice, the primary alternative is to assume that clauses are *active* by default—i.e. unless specifically marked as passive. We prefer to treat *active* voice as a lexicalized feature, but acknowledge the possibility of treating *active* voice as a simple default.

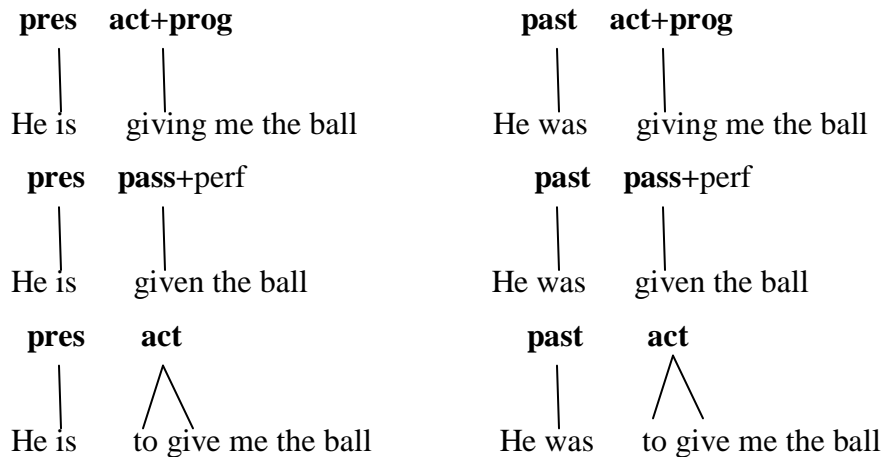
With respect to aspect, we noted above that there is some variability in the projection of *perfect* aspect from *v-en* and *v-ed* (non-finite) forms and it may be that *perfect* aspect, although encoded by “given”, does not project to the clause in this case (indicated by the absence of bold font above). Projection of *perfect* aspect may take some encouragement, either from a preceding “have” or a subsequent modifier that implies completion (e.g. “Given time, I did it”). For an approach to aspect which is more in line with Huddleston & Pullum (2002) and Quirk et al. (1985), we could treat “given” as ambiguous and create separate entries in the mental lexicon:

Given-1 isa verb	Given-2 isa verb
Type ditrans	Type ditrans
Form v-en	Form v-en
Base give	Base give
Tense' non-fin	Tense' non-fin
Tense “none”	Tense “none”
Voice pass	Voice “none”
Aspect “none”	Aspect perf

The first entry corresponds to the passive use of “given”, and the second entry corresponds to the perfect use of “given”. If we make the passive use the default, then “given” in “given time, I will

go tomorrow” will default to *passive* voice with no aspect expressed based on the first entry. On the other hand, in the context of “have” as in “I have given him the book”, the second entry will be used and express *perfect* aspect with no voice expressed. We argue below that there appear to be clauses containing v-en or v-ed (non-finite) verb forms which are both *passive* and *perfect*. The best explanation for this is that the v-en or v-ed (non-finite) verb form projects both of these features simultaneously.

If we add the auxiliary verb “be” to “give”, things start to get more interesting and we see the following possibilities:



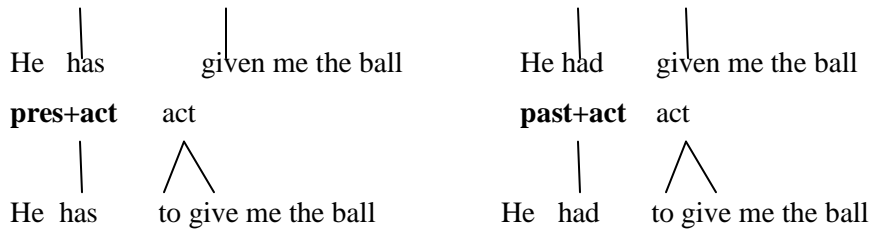
In the first example, “is” encodes and projects *present* tense and “giving” encodes and projects *active* voice and *progressive* aspect. The second example only differs in that “was” encodes and projects *past* tense.

In the third example, “is” encodes and projects *present* tense and we see the primary reason for the assumption that “is” does not encode *active* voice. Since “given” expresses *passive* voice, there would be a conflict between the *active* voice of “is” and the *passive* voice of “given”. The alternative of having “is” encode *passive* voice doesn’t work either since “is” combines with “giving” which expresses *active* voice. Restricting the encoding of voice by “is” allows “giving” to express *active* voice and “given” to express *passive* voice without conflict. In addition to expressing *passive* voice, “given” also encodes *perfect* aspect, however, we distinguish between the encoding of *perfect* aspect and its expression by or projection to the clause. “Given” has the potential to express *perfect* aspect, but there is some variability in its actual expression. For me, “given” does have a past-completion feel to it in this example, but others may disagree. The fourth example only differs in that “was” encodes and projects *past* tense.

In the fifth example, “is” encodes and projects *present* tense and “to give” encodes and projects *active* voice, but does not express any aspect. The overall effect is that the clause is *present* tense and *active* voice similar to “he gives me the ball”. However, “he gives me the ball” implies completion of the act of giving—despite our assumption that “gives” does not encode *perfect* aspect—whereas “he is to give me the ball” suggests the lack of completion of the act of giving. Note the contrast between “he is given the ball” which implies completion of the act of giving—suggesting that *perfect* aspect projects from “given”—and “he is to give me the ball” which does not. The sixth example differs in that “was” is *past* tense. Note that there is still a sense in which the act of giving was not completed, despite the *past* tense of “was”.

Adding the auxiliary verb “have” to “give” also has interesting effects.



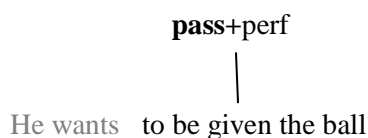


In the first example, “has” encodes and projects *present* tense and *active* voice. Projection of *active* voice by “has” implies that the subject is actively involved in the action of the following main verb, in this case “given”. Projection of *active* voice by “has” blocks the possibility of “given” projecting *passive* voice. This leaves only *perfect* aspect to project from “given”. In contrast with the more usual treatment in which “have” combines with a v-en or v-ed (non-finite) form verb to project *perfect* aspect, we propose that “have” instead has the effect of suppressing projection of *passive* voice from the immediately following v-en verb form, by projecting *active* voice. The second example only differs in that “had” projects *past* tense. If there were separate entries for the passive and perfect variants of “given”, then “have” could bias selection of the perfect entry, whereas “be” could bias selection of the passive entry. Under our current approach, “have” suppresses *passive* voice, but allows *perfect* aspect to project, whereas “be” allows both *passive* voice and *perfect* aspect to project.

In the third example, “has” encodes and projects *present* tense and *active* voice. “To give” also encodes and can express *active* voice, but this is redundant (but not incompatible) with “has”. Whereas “be” combines with “to give” to express an incomplete act of giving, “have” combines with “to give” with a nearly opposite effect—expressing an obligation to complete the act. In both cases, these effects appear to derive from the construction (e.g. “is” + “to give”, “have” + “to give”) rather than the individual lexical items. Of course, constructional effects can become encoded in complex lexical items and it is likely that “have to” is encoded in the mental lexicon (in spoken language as the equivalent of “hafta”) and expresses an obligation as part of its idiomatic meaning. The fourth example with *past* tense “had” expresses a past obligation rather than a present obligation and also has a past-completion feel (even though neither “had” nor “to give” encodes *perfect* aspect under our analysis). We leave open the question of whether or not a distinct grammatical feature for obligation is encoded by “have to”.

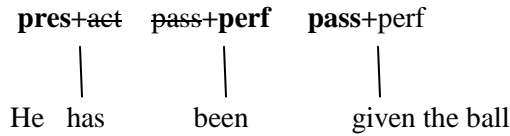
It should be noted that “have” does not combine with “giving”, although “have giving” is often used where “have given” would be more appropriate—e.g. a Google search on “have giving” yields “the Walton’s fans have giving up” and “I have giving my 60 day notice”. The same Google search does yield “How many cows can you *have giving* milk at the same time?”, but there is an implicit object of “have” that corresponds to “how many cows” in this example. This limitation appears to have something to do with the function of “have” in supporting the expression of *perfect* aspect which conflicts with the *progressive* aspect of “giving”, but “have” does not encode *perfect* aspect in our approach, it suppresses *passive* voice. Allowing “have” to encode *perfect aspect* would help explain the “have to” construction and the failure of “have” to occur with progressive verb forms, but we can explain much of the expected behavior of “have” by encoding *active* voice instead.

As a slightly more complex example, consider:



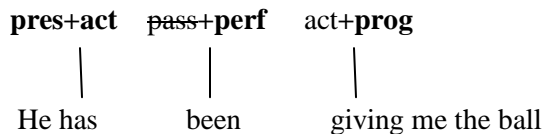
The subordinate clause “to be given the ball” is clearly *passive* with this feature being projected by “given”. It is doubtful that “to be” projects any grammatical features, since the infinitive form is *non-finite* and “be” does not encode *active* voice. Does this clause express *perfect* aspect? Probably not.

*Perfect* aspect and *passive* voice are more explicitly realized across verbal elements. Consider



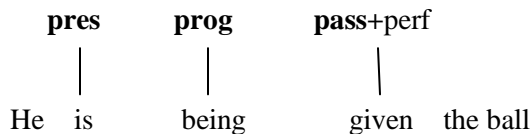
If “has” projects *active* voice, how is this clause *passive*? If we allow the *passive* voice of “given” to override the *active* voice of “has”, then the clause is *passive* overall. Although “has” blocks the projection of *passive* voice from the immediately following “been”, it does not block projection of *passive* voice from “given”. Note that if “has been” is not followed by a v-en or v-ed (non-finite) verb form it retains the active voice. For example, “he has been sad” expresses *active* voice and *perfect* aspect, whereas “he is sad” does not express either. In “he has been sad”, the referent of “he” is more actively involved in being sad than in “he is sad”. This is more evident in the contrast between “he has tired” and “he is tired” (leading many researchers to consider “tired” in “he is tired” an adjective). Note also, that both “been” and “given” encode and may express *perfect* aspect. At the clausal level, we have *perfect* aspect whether it comes from one or more verbal elements.

As the preceding example shows, it is possible to combine verb features across verbal elements in ways that are not allowed within a single verb, although one would like to assume that conflicting features cannot be simultaneously expressed, even across verbal elements. However, besides the combining of *perfect* aspect and *passive* voice—which represent different dimensions of meaning and do not conflict—surprisingly, *perfect* aspect and *progressive* aspect can also be combined across verbal elements.



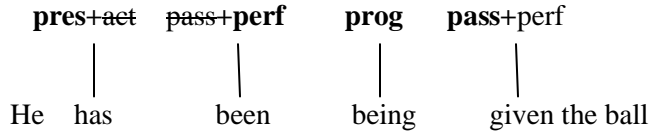
In this example, “has” expresses *present* tense and *active* voice, “been” expresses *perfect* aspect, with *passive* voice blocked, and “giving” expresses *progressive* aspect and secondarily *active* voice. It is an open research question how it is possible to combine two aspectual features—*perfect* and *progressive* aspect—in a single clause, although in this example it may be that the combination results in an iterative interpretation that is at once *progressive* in iterating and *perfect* in the completion of each iteration (e.g. “He has been giving me the ball over and over”).

*Progressive* aspect can be combined with *passive* voice across verbal elements.



In this example, “is” projects *present* tense, “being” projects *progressive* aspect, and “given” projects *passive* voice. Note that neither “is” nor “being” project *active* voice since they are both instances of “be”. It is unclear again if “given” projects *perfect* aspect.

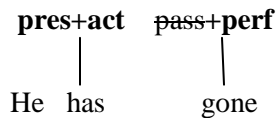
*Perfect* aspect can combine with *progressive* aspect and *passive* voice across verbal elements.



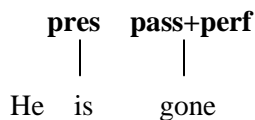
In this example, “has” projects *present* tense and *active* voice, but *active* voice is subsequently overridden by the *passive* voice of “given”, “been” projects *perfect* aspect, with *passive* voice being blocked by “has”, “being” projects *progressive* aspect, and “given” projects *passive* voice, overriding the *active* voice of “has”, with *perfect* aspect questionable. On the assumption that this expression is a single clause, this clause expresses a complex collection of tense, aspect and voice features across four verbal elements.

## 4.2 Verb Feature Projection for “Go” and other Intransitive Verbs

It is when we consider intransitive verbs like “go”, that the commitments made for transitive verbs like “give” begin to make more sense. The intransitive v-en form is especially revealing. Consider the verb “gone”.

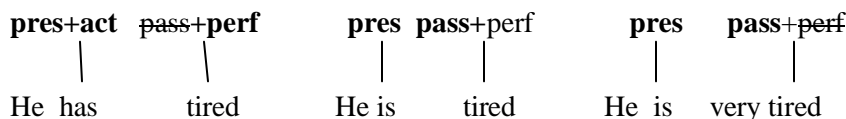


Like typical v-en forms of transitive verbs, “gone” expresses *perfect* aspect when preceded by “has”. But why do we need *passive* voice for intransitive verbs? Because intransitive verbs can occur with “be” just like transitive verbs:



There is clearly an expression of past-completion in this example, but the active involvement of the referent of “he” is de-emphasized. This de-emphasis is the intransitive verb equivalent of passivization in transitive verbs. In the intransitive verb case, there is no object available to be promoted to the subject function. Instead, the subject of the intransitive verb is demoted from active participant to passive participant, but remains the subject.

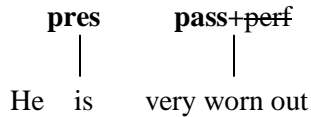
Now consider a set of even more revealing examples:



In “he has tired”, “tired” is the v-ed (non-finite) verb form. Since “has” projects *active* voice, the *passive* voice of “tired” is blocked, but *perfect* aspect projects. In “he is tired”, it is unclear if *perfect* aspect projects. If it doesn’t, then the clause is *present* tense and *passive* voice. Since “tired” is an intransitive verb, *passive* voice demotes the subject making it a passive participant. We are left with an expression that has essentially the same force as an adjectival expression—a single subject argument that is a passive participant, and an auxiliary + main verb combination that lacks any aspectual feature. If we view *stative* force as the lack of any aspect, then the expression is effectively *stative*. Many researchers, including Huddleston & Pullum (2002) and Quirk et al. (1985) treat “tired” in the latter two examples as an adjective. Huddleston & Pullum (2002, p. 1436) claim that the ability of a word like “tired” to combine with the adverb “very” is a definitive test for an adjective. Quirk et al. (1985, p. 167) make a similar claim. However, it is hard to see how this test is definitive given that “tired” has the form of a v-ed verb. The

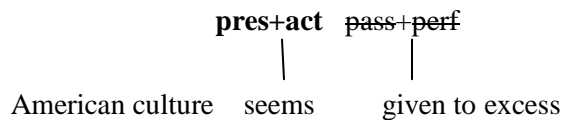


assumption that “tired” is an adjective when combined with “be” and a verb when combined with “have” necessitates two entries in the mental lexicon to represent “tired”. The approach advocated here requires a single verb entry, but allows the context (or even the specific lexical item) to control the projection of grammatical features such that an intransitive verb can function very much like an adjective. As a challenge to the claim that “very” definitively identifies an adjective, consider

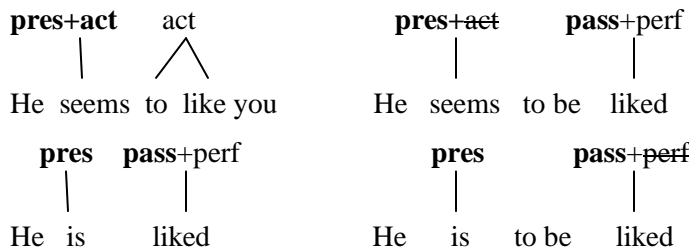


It is atypical of adjectives, and typical of verbs to combine with prepositions to form verb-particle constructions. “Worn out” appears to be a typical verb-particle construction, except that it can be occur with “very”.

Besides the “very” test, Huddleston & Pullum (2002) and Quirk et al. (1985) suggest that the ability of “tired” to combine with “seem” as in “He seems tired” provides additional evidence for treating “tired” as an adjective—only adjectival phrases occur after “seems”. Of course, this is only true by definition. An alternative is to suggest that at least some v-en or v-ed-or-en form verbs may occur after “seem”. When they do, their *perfect* aspect feature is suppressed, making them very similar to adjectives. Note that “seem” is quite special in that it also allows infinitives as in “He seems to like you”. What is allowed to follow “seem” is a subordinate clause lacking tense and aspect, but allowing voice—in the case of an infinitive, *active* voice. If the *perfect* aspect of “tired” can be suppressed, then since it is *non-finite*, it can occur with “seem”. The question is then whether “seem” combines with verb forms that express *passive* voice. Googling “seems given” returns the hits “the band seems given to frequent drum rolls”, “particular credence seems given to the belief that carbohydrate consumption is a causative factor” and “it seems given that the new PSP is network enabled”. “Seems” and “given” do occur together, however, it is not clear that these expressions are *passive*. If *passive* voice is also suppressed by “seems”, then “given” can still be a verb in these expressions, albeit one that does not express any verbal features.



How does “seem” suppress *passive* voice? By projecting *active* voice. Unlike “be” which does not express *active* voice, “seem” appears to do so.



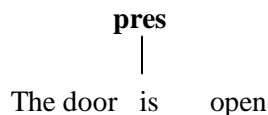
In “he seems to like you”, both “seems” and “to like” express *active* voice and there is no conflict, but “to like” lacks tense and aspect features. In “he seems to be liked” we have a *passive* construction. Even though “to be” does not project any features itself, it is the immediate neighbor of “liked” and that allows “liked” to project *passive* voice, overriding the *active* voice of “seems”. “Liked” may also project *perfect* aspect. Compare “he seems to be liked” to “he is liked” where “seems” projects *active* voice, but “is” doesn’t. There is no need for an intervening

infinitive in the case of “is” in order to express *passive* voice, although “he is to be liked” is also possible, with *perfect* aspect likely being suppressed. Further, googling “seems liked” and “seems loved” retrieves:

13. I’m liking dane and he *seems liked* in the house as well
14. he *seems liked* by many
15. his teammates come to his defense, so he *seems liked* enough
16. Alex certainly *seems loved* and admired by so many
17. We’re amazed that the school has blossomed into a nurturing co-ed community that *seems loved* by all
18. Vanilla *seems loved* by adults and children alike

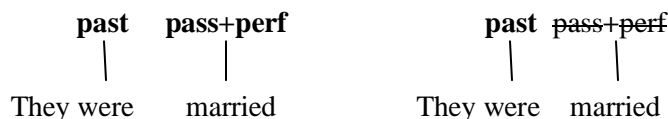
These examples show that at least some English texters allow “seems liked” and “seems loved” to be used as *passive* constructions. Presumably in these cases, “seems” patterns after “be” and lacks *active* voice, allowing the *passive* voice of “liked” and “loved” to be expressed, or exceptionally, the *passive* voice of “liked” and “loved” overrides the *active* voice of its immediate predecessor. Even if “seems liked” and “seems loved” are viewed as grammatically inappropriate like the earlier “have giving”, we presume that humans can still make some sense of such constructions. The author of this paper had a friend who frequently used the “giving that” construction as in “Giving that you speak English well, you should really say ‘given that’”. Although the author found this coinage annoying, he was still able to interpret it. In sum, “seem” combines most readily with adjectives, and the v-en or v-ed (non-finite) form of stative verbs—suppressing *perfect* aspect in the latter. “Tired”, “liked” and “loved” are quite stative, “given” less so. Why stative verbs are verbs and not adjectives in English is an interesting question, but they **are** verbs **not** adjectives and they combine with “seem”—calling into question the use of “seem + adjective” as a definitive test for adjectives.

In general, we argue against the dual treatment of inflected verbs, including stative verbs, as adjectives since this introduces an ambiguity that does not facilitate processing. However, this does not mean that there is never an ambiguity between verbs and adjectives. Consider

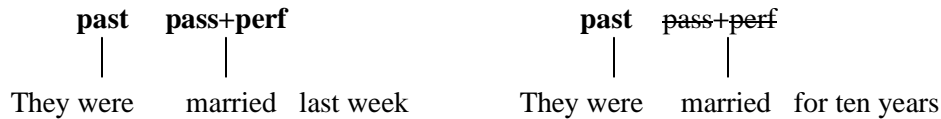


“Open” appears to be a genuine adjective in that it does not have any verb inflection and it occurs after “is” where bare verb forms do not occur. If “open” is genuinely ambiguous, how does the incremental, pseudo-deterministic processor deal with it? If we restrict “is” to setting a bias for non-finite inflected verb forms (e.g. v-ing, v-en or v-ed), adjectives and prepositions, then “open” will be biased to the adjective, rather than the v-bare verb form, in the context of “is”. Note that this bias will not be sufficient if “gone” is both a v-en verb form and adjective, or “tired” is both a v-ed (non-finite) verb form and adjective.

Huddleston & Pullum (2002, p. 1436) note that expressions like “they were married” are ambiguous between an adjectival and a verbal interpretation. In “they were married last week” the verbal interpretation dominates, and in “they were married for ten years” the adjectival interpretation dominates. Is it possible to handle this ambiguity without positing distinct entries in the mental lexicon?

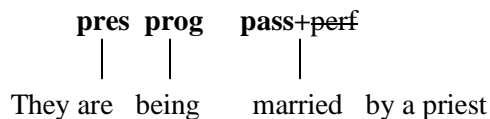


If the verbal interpretation corresponds to the projection of *perfect* aspect and *passive* voice, and the adjectival interpretation corresponds to suppression of *perfect* aspect and *passive* voice, then we can represent the distinction without positing separate entries in the mental lexicon. One immediate advantage of this approach is an ability to handle post verbal modification via feature overriding:



In the first example, the relatively punctual nature of “last week” encourages the expression of *perfect* aspect, whereas in the second example, the durative nature of “for ten years” discourages and perhaps overrides the expression of *perfect* aspect. The “adjectival” use also appears to lack *passive* voice. In the case of transitive verbs like “marry”, *passive* voice applies to the event reading in which the agent of the event (e.g. the priest) is demoted from subject to optional oblique argument. In the case of “they were married for ten years” we have a durative event that is stative-like and lacking an agent (what about “they were married to each other for ten years”). Note that at the processing of the word “married” we do not know what affect post verbal modifiers will have or even if there will be any. In an approach which has separate verb and adjective entries for “married”, an incremental, pseudo-deterministic processor will run into problems. It is not possible to decide at “married” which entry is needed. Either both entries will need to be carried forward in parallel, or the processor must have some mechanism for backing up and trying the alternative. From a processing perspective, neither of these is attractive. The human language processor does not have sufficient resources to carry forward multiple options in parallel, at least not across multiple choice points where additional parallelism might be required. Backtracking is equally problematic. Resources are needed to store the alternatives to be considered on backtracking, and knowing when to backtrack is indeterminate. Our pseudo-deterministic processor eschews backtracking and constrains parallel propagation of alternatives (although we present an example below in which “have” temporarily propagates multiple alternatives in parallel), relying instead primarily on non-monotonic adjustment of the evolving representation via feature overriding and feature blocking to deal with many forms of ambiguity without positing multiple entries in the mental lexicon.

As a final example with “married”, consider

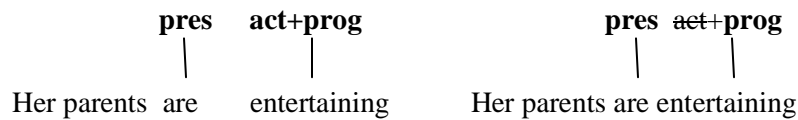


In this example, “are” expresses *present* tense and “being” expresses *progressive* aspect. Since “are” and “being” are forms of “be”, they do not express *active* voice. This allows “married” to express *passive* voice, but the *perfect* aspect of “married” is blocked by the *progressive* aspect of “being”. The result is a clause that is *present progressive* and *passive*. There is an ambiguity here that relates to the lack of *perfect* aspect: are they in the act of being married by a priest or is the event just planned for the future? In “they are to be married by a priest” the future interpretation dominates. Since the *present* tense ranges over future events, this ambiguity may not be resolvable in terms of feature projection or suppression.

There is a related ambiguity in the meaning of expressions with *progressive* verb forms. According to Huddleston & Pullum (2002, p. 80)

Her parents are entertaining

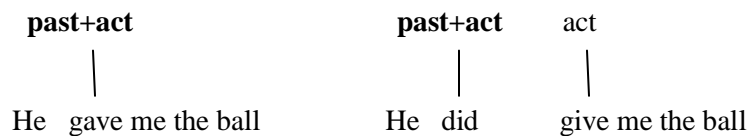
is ambiguous between “entertaining” as a progressive verb form and “entertaining” as a stative adjective. If we allow the *active* voice feature of “entertaining” to be suppressed then these two uses can result from a single verb entry:



It does not seem necessary to suppress *progressive* aspect in this example since *progressive* aspect is already stative-like compared to *perfect* aspect. Note that this allows us to handle “her parents are entertaining tomorrow” and “her parents are entertaining to be around” via feature projection or suppression without multiple entries in the mental lexicon.

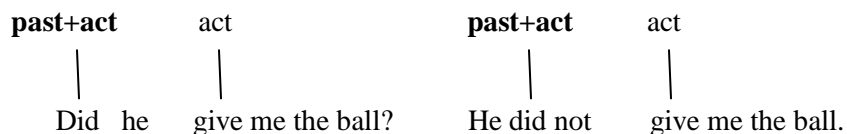
### 4.3 “Do” as an Auxiliary Verb

The primary function of “do” when used as an auxiliary verb in a declarative sentence is to provide emphasis. For example, “he did give me the ball” can be contrasted with “he gave me the ball”.



Both expressions are *past* tense and *active* voice. In the case of “did give”, the active voice of “give” is redundant with the active voice of “did”. The overall effect is to emphasize the active nature of the expression, perhaps by the dual expression of active voice.

“Do” has a special do-support function in yes-no questions and negative clauses, providing support for auxiliary inversion in the case of tensed main verbs which aren’t typically inverted in English and projecting tense where “not” combines with a bare verb form. Consider “Did he give me the ball?” which corresponds more closely to “He gave me the ball” than to the emphatic “He did give me the ball”.



We leave open the question of whether or not the emphatic “do” should express a distinct grammatical feature.

### 4.4 “Be”, “Have” & “Do” as Transitive Verbs

Up to this point, we have only discussed auxiliary verb uses of “be”, “have” and “do”, attempting to minimize ambiguity in these uses. It is also generally assumed that these verbs have main verb uses as well. We leave open the possibility that “be” is a transitive verb in its equative use and accept that “have” and “do” can be used transitively.

For the most part, we treat “be” as an auxiliary verb even in predicate nominal expressions like “he is a man”.

Graphic goes here!

In this expression “is” functions as clausal specifier and “a man” functions as clausal head (i.e. a predicate nominal). On the other hand, in “he has it”, we treat “has” as a transitive verb taking

two arguments “he” and “it” with “has” functioning as the head of the clause. Similarly for “he did it”. For the transitive uses of “have” and “do” the following entries in the mental lexicon are needed:

Have isa verb	Has isa verb	Had isa verb
Type trans	Type trans	Type trans
Form v-bare	Form v-s	Form v-ed-or-en
Base have	Base have	Base have
Tense' fin	Tense' fin	Tense' fin
Tense pres	Tense pres	Tense past
Voice act	Voice act	Voice act
Aspect “none”	Aspect “none”	Aspect “none”

Have isa verb	To-have isa verb
Type trans	Type trans
Form v-bare	Form to+v-bare
Base have	Base have
Tense' non-fin	Tense' non-fin
Tense “none”	Tense “none”
Voice act	Voice act
Aspect “none”	Aspect “none”

Having isa verb	Had isa verb
Type trans	Type trans
Form v-ing	Form v-ed
Base have	Base have
Tense' non-fin	Tense' non-fin
Tense “none”	Tense “none”
Voice act	Voice pass
Aspect prog	Aspect perf

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Do isa verb	Does isa verb	Did isa verb
Type trans	Type trans	Type trans
Form v-bare	Form v-s	Form v-ed-or-en
Base do	Base do	Base do
Tense' fin	Tense' fin	Tense' fin
Tense pres	Tense pres	Tense past
Voice act	Voice act	Voice act
Aspect “none”	Aspect “none”	Aspect “none”

Do isa verb	To-do isa verb
Type trans	Type trans
Form v-bare	Form to+v-bare
Base do	Base do
Tense' non-fin	Tense' non-fin
Tense “none”	Tense “none”
Voice act	Voice act
Aspect “none”	Aspect “none”

Doing isa verb	Done isa verb
Type trans	Type trans
Form v-ing	Form v-ed-or-en
Base do	Base do
Tense' non-fin	Tense' non-fin
Tense “none”	Tense “none”
Voice act	Voice pass
Aspect prog	Aspect perf

Given the ambiguity between the auxiliary verb and transitive verb uses of “have” and “do”, how is this ambiguity managed, especially since it is not known at the processing of “have” and “do” which entry is relevant for most verb forms? To handle this ambiguity, we need some capability to temporarily carry forward both options in parallel. At the processing of “have” and “do”, we assume their primary treatment as auxiliary verbs combined with their secondary treatment as transitive verbs. To accomplish this, the processor proceeds as if the verb is an auxiliary verb, but keeps the transitive use available should it be needed. To see how this works, consider the processing of “he has it”. At the processing of “has”, it is identified as an auxiliary verb. As an auxiliary verb, it projects a clause in which it functions as the specifier. At the same time, its separate identification as a transitive verb leads to projection of a transitive verb construction with a prediction for an object to occur. This transitive verb construction is maintained separately and is not integrated into the clause. Once the clause is projected, “he” is integrated as the subject of the clause and the initial processing of “has” is completed. If “has” were followed by a v-en verb form (e.g. “he has gone”), then the v-en verb form would be integrated as the head of the clause. However, in this example, “has” is followed by the pronoun “it”. The processing of “it” leads to projection of a nominal. In the context of a clause with “has” functioning as the specifier, the processing of the nominal “it” leads to removal of “has” as the specifier of the clause and integration of the transitive verb construction containing “has” as the head of the clause instead. The nominal “it” is then integrated as the object of the transitive verb construction. The mechanism by which “has” the clausal specifier is removed and “has” the transitive verb construction is integrated as the head of the clause, is a form of context accommodation. In this case, we are not simply overriding an existing clausal function, but replacing one function (i.e. clausal specifier) by another (i.e. clausal head). Since the transitive verb construction was projected in parallel with the integration of “has” the auxiliary verb as the clausal specifier, this accommodation can be accomplished efficiently without backtracking. However, we assume that the human language processor has limited capacity to carry forward multiple structures in parallel and no capacity to build multiple structures in parallel. There is no sense in which the model is at once building a clause with “has” functioning as an auxiliary verb specifier, and a separate clause with “has” functioning as a transitive verb head. A single clause is being constructed.

When functioning as transitive verbs, “have” and “do” combine with regular auxiliaries just as other main verbs do and we unsurprisingly get expressions like “he has had it” and “he did do it”. Just like other main verbs, they express voice and aspect features that combine in predictable ways with the tense and voice features of the auxiliary verb. In the case of “have”, *passive* voice may be lacking, although “a good time was had by all” appears to constitute a passive, if idiomatic, use of “had”.

#### 4.5 Beyond Transitive Uses

It would be nice if auxiliary and transitive uses of “have” and “do” exhausted their range, but they don’t. Both “have” and “do” occur in constructions that take more than two complements (i.e. subject and object). In the case of “have” we have

19. He had it engraved
20. He had me going
21. He had it to eat

How can we handle these constructions in an incremental, pseudo-deterministic processor? Note that in these examples, the additional complement of “have” is *non-finite*. If we posit a *non-finite* complement beyond the object complement then we can handle these examples. Basically, at the processing of the nominal following “have”, when the model determines that “have” is a transitive verb rather than an auxiliary verb, in parallel with that determination the model projects

a construction that allows for an additional *non-finite* complement. If a *non-finite* complement occurs, then the parallel double complement structure replaces the transitive structure. Were that language were so simple! Unfortunately, we also have examples like

22. He had me eat it

which challenge our analysis. If the bare verb form “eat” always projects *present* tense and is *finite* then we either need to allow the extra complement of “have” to be either *non-finite* or *finite*, introducing an ambiguity, or we need to reconsider our claim that the bare verb form is always *finite*. Contrary to Huddleston & Pullum (2002), it is still possible that the bare verb form is *finite* (i.e. *present* tense) in imperative and subjunctive constructions. Only in constructions which require a *non-finite* bare verb form need the bare verb form be *non-finite*. This is the position we adopt. The bare verb form is *present* tense and *active* voice by default (i.e. in imperative and subjunctive constructions), but in specific contexts it may be *non-finite*, especially in contexts where the bare verb form is the complement of a verb (e.g. “go” in “he made me go”).

“Do” also occurs in double complement constructions. Consider “he did me a favor”. When “me” is processed following “did”, the auxiliary verb use of “did” is replaced by the transitive verb use which was projected in parallel. In addition, a double complement construction allowing for an additional nominal is projected in parallel with the shift to the transitive construction. If a second nominal following “do” occurs, the double complement construction replaces the transitive construction.

We see that the basic processing mechanism for handling additional complements involves the parallel projection of a structure supporting the additional complement, one at a time. If an additional complement occurs, this parallel structure is put into service, otherwise it is discarded. We leave it open whether multiple additional parallel structures are needed to handle different types of complements, but assume that in general there is very limited capacity to project multiple structures in parallel.

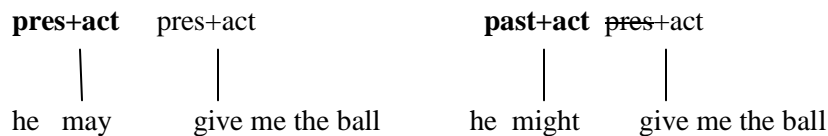
## 4.6 Modal Auxiliaries

Unlike tense, aspect and voice which are marked inflectionally on verbs (including auxiliary verbs), the expression of modality is lexicalized, not grammaticalized, in English. There is a small collection of modal auxiliaries expressing different types of modality which combine with (non-modal) auxiliary verbs and main verbs in predictable ways. In this section we are not concerned with modality per se, but with the encoding of tense and voice in modal auxiliaries. We assume that modal auxiliaries do not encode for aspect.

Huddleston & Pullum (2002) argue that the modal auxiliaries do express tense. Inflectionally, the encoding of tense is reflected in the contrast between pairs like: “can” and “could”, “will” and “would”, “shall” and “should”, and “may” and “might”, with the first of the pair encoding *present* tense and the second encoding *preterite* tense (what we call *past* tense). We will see below that there are difficulties with this contrast. Huddleston & Pullum (2002) do not consider the possibility that modal auxiliaries also encode *active* voice. It is true that there is no contrast between *active* and *passive* voice since modal auxiliaries do not have a v-en form. Modal auxiliaries either pattern like “be” in not encoding voice or they pattern like “have” and “do” in encoding *active* voice. Under the assumption that some verbal element in a clause encodes voice, since modal auxiliaries combine with bare verb forms as in “he may give me the ball”, either the modal auxiliary “may” encodes *active* voice, the bare verb form “go” encodes *active* voice, or both do. We assume that both do, but that the *active* voice of the modal auxiliary and bare verb form may be overridden in appropriate contexts (e.g. “he may been given the ball”).

The modal auxiliary is always the first element of a verb group. This element has a privileged status relative to other elements of the verb group and is called the “operator” by Quirk et al. (1985). The operator is involved in subject-auxiliary inversion (e.g. compare the modal “may” in “may I go?” to “did he go?” and “is he going?”) and precedes the negative “not” in negative expressions (e.g. “he could not go” vs. “he did not go” and “he is not going”). The fact that “did” and “is” encode and express tense in these constructions is strong evidence that the modal auxiliary does as well. The fact that modal auxiliaries pattern like “do” rather than “is” in combining with bare verb forms (e.g. “he may go” and “he did go”) suggests that they align with “do” in encoding *active* voice, in contrast to “be” which does not encode voice. However, “do”, like “have”, implies an active participant functioning as the subject. “May” does not appear to carry this implication, although “must” in “he must go” does. It may be that encoding and expression of *active* voice varies from modal auxiliary to modal auxiliary. In fact, “may” in “you may go” is ambiguous between a reading in which “may” has strong force (i.e. “in fact, I insist that you go”) and a reading in which “may” has weak force (i.e. “if you want”). This might be explained by the expression of *active* voice or not (I’m not sure I believe this!!!).

Regardless of whether or not modal auxiliaries encode and express *active* voice, our first challenge is in explaining how they combine with bare verb forms which express *present* tense and *active* voice in our analysis. In the section 3.3, we argued that “did” in “he did give me the ball” encoded and projected *past* tense and *active* voice, with the *past* tense of “did” blocking projection of *present* tense by “give”. Modal auxiliaries may behave similarly:



In the first example, the redundancy in the encoding and expression of features across the modal auxiliary and bare verb form is not desirable, but there is no conflict. In the second example, there is an undesirable conflict between the *past* tense feature of “might” and the *present* tense feature of “give”. Although undesirable, such conflicts are not unattested. But does “might” really express *past* tense? Since “he might give me the ball, now” and “he might give me the ball, tomorrow” are both reasonable, whereas “he might give me the ball, yesterday” is awkward, it does not appear that “might” encodes and expresses *past* tense. Rather, “might” appears to encode and express *non-past* tense (what we more usually call *present* tense). If both “may” and “might” encode and express *non-past* tense, then there is no tense contrast between these two forms. This suggests that “may” and “might” may be better treated as distinct lexemes rather than form variants of the same lexeme. There contrast in meaning is not inflectional, it has to do with the strength of the modality that they express. The same can be said for “can” and “could”, “will” and “would” and “shall” and “should”.

May isa aux	Might isa aux
Type modal	Type modal
Form v-bare	Form v-ed
Base may	Base may or might
Tense' fin	Tense' fin
Tense pres	Tense pres
Voice act	Voice act
Aspect “none”	Aspect “none”
Can isa aux	Could isa aux
Type modal	Type modal
Form v-bare	Form v-ed
Base can	Base can or could



Tense' fin	Tense' fin
Tense pres	Tense pres
Voice act	Voice act
Aspect "none"	Aspect "none"
Will isa aux	Would isa aux
Type modal	Type modal
Form v-bare	Form v-ed
Base will	Base will or would
Tense' fin	Tense' fin
Tense pres	Tense pres
Voice act	Voice act
Aspect "none"	Aspect "none"
Shall isa aux	Should isa aux
Type modal	Type modal
Form v-bare	Form v-ed
Base shall	Base shall or should
Tense' fin	Tense' fin
Tense pres	Tense pres
Voice act	Voice act
Aspect "none"	Aspect "none"

These modal auxiliaries may be lexically distinct, rather than being differing forms of the same lexeme. Under this analysis, it is not surprising the “must”

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Must isa aux
Type modal
Form v-bare
Base must
Tense' fin
Tense pres
Voice act
Aspect "none"

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only has one form. Since “must” is the strongest modal auxiliary, there is not a contrasting weaker form, unless it is “may” which is realized as a separate lexeme.

The representation of modal auxiliaries as distinct lexemes—i.e. separate entries in the mental lexicon—helps explain their differing and often idiomatic grammatical behavior. For example, the behavior of “couldn’t” is distinct from that of “could”. We can say “he couldn’t go yesterday”, “he couldn’t go now” and “he couldn’t go tomorrow”, but “he could go yesterday” is awkward. Likewise for “wouldn’t” and “would”. The negative forms have a wider range of uses, suggesting their separate representation in the mental lexicon. If we add a second tense entry and a value for polarity for the negative forms we have:

Couldn't isa aux	Wouldn't isa aux
Type modal	Type modal
Form v-ed	Form v-ed
Base could	Base would
Tense' fin	Tense' fin
Tense pres	Tense pres
Tense-2 past	Tense-2 past
Voice act	Voice act
Aspect "none"	Aspect "none"
Polarity neg	Polarity neg

These entries allow us to explain the distinct behavior of “couldn’t” and “wouldn’t”:

<b>past+pres+act</b>	<b>pres+act</b>	<b>past+pres+act</b>	<b>pres+act</b>

he couldn't go yesterday he couldn't go now/tomorrow

We also need to handle the case where negative polarity is indicated by “not” as in “I could not go yesterday” and “I would not go yesterday”.

pres+act pres+act pres+act pres+act  
 | | | |  
 he could not go yesterday he would not go yesterday

As it stands, this is not a primary use of “could” and “would”, since “could” and “would” don't encode *past* tense. Somehow the *past* tense indication of yesterday is able to override the *present* tense of “could” and “would” in a negative context. The negative also influences the expression of *perfect* aspect in expressions with “can”: “he can have gone” is awkward, but “he can't have gone” is OK. Only the negative “can't” or “cannot” allows a subsequent expression of *perfect* aspect. If the negative has the effect of suppressing or overriding the preceding *present* tense, then the *perfect* aspect of “gone” can project. Why the *perfect* aspect of “gone” cannot occur with the *present* tense of “can” without the negative is unexplained.

pres+act pres+act pass+perf  
 | | |  
 he can't have gone

The expression of *perfect* aspect and suppression of *passive* voice provides additional support for not assuming a *non-finite* verb form lacking both tense and voice following the modal auxiliary. Consider

pres+act pres+act pass+perf  
 | | |  
 he could have gone yesterday

In this example, the *passive* voice of “gone” is suppressed by the *active* voice of “have”, but *perfect aspect* is expressed. Note that if “have” did not encode *active* voice, then given our earlier assumptions, “gone” could express *passive* voice since it is not the immediate neighbor of “could”. As a minimum, the bare verb form following “could” needs to be able to express voice, at least in the case of “have”.

Finally, we consider the possibility that “will” is lexicalized for *future* tense. Since we can say “he will go now” and “he will go tomorrow”, either “will” behaves like a typical modal auxiliary in encoding and expressing *non-past* tense which encompasses future events, or “will” exceptionally encodes both *present* and *future* tense.

Will isa aux  
 Type modal  
 Form v-bare  
 Base will  
 Tense' fin  
 Tense pres  
 Tense-2 future  
 Voice act  
 Aspect “none”

pres+fut+act pres+act pres+fut+act pres+act

he will            go now            he will            go tomorrow

Adding a *future* tense to “will” allows us to treat it as a primary use. This addition is warranted if the default behavior of “will” is to express future tense. Does “I will go” express *future* tense? In a check with three informants, none felt that “I will go” was synonymous with “I will go later”.

## 5. Processing Complex Verb Groups

The previous section discussed the range of combinations of auxiliary and main verbs that occur in English. Yet to be discussed is how these combinations are processed. Within the context of an incremental, pseudo-deterministic human language processor, we make an additional commitment to building the minimal structure necessary. This commitment stems from the rapidity with which humans process language and to adoption of an approach to linguistic representation which aligns with the Simpler Syntax of Culicover & Jackendoff (2005). To the extent that structure building is a serial, time consuming process, it needs to be minimized. There simply isn’t time to build unnecessary structure. On the other hand, when that structure is actually needed, it needs to be readily available. How are these conflicting requirements satisfied? By introducing a limited amount of parallelism. When an auxiliary verb is processed, it is treated as the last auxiliary in the input, however, in parallel, an alternative structure is constructed in which a subsequent auxiliary may be integrated. For example, consider the processing of “he has...”. At the processing of “has”, “has” is recognized as an auxiliary verb which projects a clause and functions as the specifier of the clause. In parallel, a structure is built which allows a second auxiliary verb to be integrated. If “has” is followed by the main verb “gone”, “gone” is identified as a verb and integrated as the head of the clause. In this case, the parallel structure which supports a second auxiliary is discarded. On the other hand, if “has” is followed by “been”, the parallel structure replaces “has” as the specifier of the clause and “been” is integrated as the second auxiliary. In parallel, a new structure is built which supports integration of a third auxiliary. If “been” is followed by the main verb “gone”, “gone” is identified as a verb and integrated as the head of the clause. The parallel structure is discarded in this case. If “been” is followed by “being”, then the parallel structure replaces the “has been” structure and “being” is integrated as the third auxiliary.

The reason for building these alternative structures in parallel and predicting subsequent auxiliaries is for efficiency of processing. There are two primary alternatives: 1) build sufficient structure to handle all auxiliaries at the processing of the first auxiliary, and 2) build the needed structure only when subsequent auxiliaries actually occur. The first alternative leads to the generation of unnecessary structure for most inputs. The second alternative requires serial construction of structure on an as needed basis and is less efficient than the parallel generation of alternative structures. The adopted approach is a reasonable compromise between these two alternatives. However, note that the processing of “have” already requires the generation of an alternative transitive verb structure in parallel with the treatment of “have” as an auxiliary verb. We now have a model that builds two alternative structures in parallel—one to handle the possibility of a second auxiliary verb, and one to handle the transitive verb use.

## 6. Imperative and Subjunctive Constructions

An advantage of the approach promoted in this paper is in the treatment of imperative and subjunctive constructions. Since the bare verb form encodes *present* tense and *active* voice, imperative and subjunctive clauses can acquire tense and voice from these bare verb forms. Consider,

**past+act**

**pres+act**

Give me the ball!

They demanded that he give me the ball

Huddleston & Pullum (2002) argue that imperative and subjunctive constructions are tensed, but that the tense comes from the construction, not the bare verb form. In our approach, both *present* tense and *active* voice are encoded in the bare verb form—independent of any construction—and these features may project to the clause in a construction determined manner.

## 7. Summary

We assume an incremental, pseudo-deterministic human language processor which imposes severe constraints on the processing of the grammatical features of verbal elements. Verbs, including auxiliary and modal verbs, are encoded with tense, aspect and voice features in the mental lexicon and these features can project to, or be expressed by, the clause. When the verb group contains multiple elements, the grammatical features of the verbal elements must be reconciled. Monotonic unification of grammatical features is not possible when the grammatical features conflict. Non-monotonic mechanisms of feature blocking and overriding are needed to handle the reconciling of incompatible features.

Although informed by the analysis of Huddleston & Pullum (2002) and Quirk et al. (1985), our approach differs in important respects. Most notably, we recognize a clausal specifier function distinct from the function of the clausal head. The verb group, less the main verb, fulfills the function of clausal specifier, whereas the main verb fulfills the function of clausal head. We do not view the relationship between clausal specifier and clausal head as a dependency relationship. The relationship is closer to one of secondary heads (cf. Cann, 1999), although we do not use that terminology. Based on the existence of distinct specifier and head functions, the catenative treatment of auxiliaries advocated by Huddleston & Pullum needs to be modified. There are two loci for concatenation of verbal elements, and auxiliary verbs do not function as clausal heads taking verbal element complements. Instead they combine together within the specifier function. We also prefer the Simpler Syntax approach of Culicover & Jackendoff in which auxiliaries combine together without nesting in a flat tree structure.

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