Diathesis Alternations and Rule Interaction in the Lexicon

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1. Introduction: two types of rules

Wasow (1977) argues that syntactic theory should recognize two qualitatively different types of rules. He characterizes those as lexical rules and transformational rules. The central case study he looks at is that of adjectival vs. verbal passive. The distribution of the prefix *un-* is evidence that some participles should be considered adjectives. *Un-* can attach to a participle and to an adjective, as in (1a) and (1b). The verb from which this participle is derived, however, cannot take the prefix (1c). These facts can be explained if *un-* is constrained to combine with adjectives, and the participle in (1a) is taken to be an adjective. However, there are contexts in which a participle can appear (2a), but which exclude adjectives (2b).

(1) a. Her whereabouts may be unknown.
b. They were an unhappy couple.
c. *We unknow her whereabouts.

(2) a. Mary was elected president.
b. *Mary was happy president.

Adjectival participles, then, must be distinguished from passive participles despite their morphological similarities. Their differences, Wasow argues, follows from the claim that adjectival passives are derived lexically and that verbal passives are derived transformationally.

Examining adjectival and verbal passives in detail and other hypothesized lexical vs. transformational rules, Wasow characterizes the properties that distinguish the two classes: Lexical rules do not affect structure, may

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change part of speech, are extremely local, cannot be "fed" by transformations and are subject to idiosyncratic exceptions. Transformations are not necessarily structure-preserving (cf. wh-movement), do not change part of speech, are not necessarily local, can be fed by other transformations and ideally are not subject to idiosyncratic exceptions. A model that recognizes lexical rules as well as transformational rules can account for these distinctions in a natural way.

However, ever since Bresnan's (1982) influential analysis of verbal passive, lexicalist theories of grammar have replaced syntactic transformations with lexical rules. This shift leaves potentially unexplained the dichotomy of rule types that Wasow argues for: if all rules are lexical, then the differences between the properties of the two types of rules cannot be identified with differences between the lexical and syntactic components of the grammar. We believe that Wasow was fundamentally correct in recognizing two qualitatively different types of rules and it is our goal in this paper to offer a proposal for how to recapture Wasow's insight in a lexicalist framework like HPSG.

Our proposal is to account for Wasow's insights by recognizing two types of lexical rules. We build on the analysis of Sag & Wasow (1999) who argue that there are two types of lexical entries –lexemes and words. Lexemes are sometimes referred to as 'stems', while words are the fully inflected forms that enter into the syntax. We claim that there is a contrast between lexical rules that relate lexemes to lexemes (L-to-L rules) and lexical rules that relate words to words (W-to-W rules). L-to-L rules may affect the lexical semantics of a lexical item (i.e. changing the number and nature of semantic roles, or the semantic structure of the predicate), while W-to-W rules only affect its argument structure (i.e. changing the grammatical functions assigned to the semantic roles).

In this paper we will argue in particular that this distinction can be used to explain certain differences between dative shift (DS) (3) and the Spray/ Load (S/L) alternation (4).

(3) a. Chandler gave a summons to the veterinarian.
    b. Chandler gave the veterinarian a summons.

(4) a. Rachel loaded the wheelbarrow with coconuts.
    b. Rachel loaded coconuts into the wheelbarrow.

Our claim is that DS is a W-to-W rule and that the S/L alternation is an L-to-L rule. The rules themselves will be illustrated below.

We chose these particular constructions because in a recent paper Baker (Baker 1997) argues that DS is a transformational rule, and the S/L alternation a lexical rule. We agree with Baker on the qualitative difference between

these rules, but we reject his claim that it reflects a syntax vs. lexicon dichotomy. So our goal here will be to show that Baker's analysis, which rests on a transformation/lexicon distinction, is incorrect, and that a better analysis is a lexical one that recognizes two qualitatively different lexical rule types.

2. Some background

2.1. HPSG

Head-driven Phrase Structure Grammar is a lexicalist approach to syntax; as in other lexicalist frameworks grammatical function changing operations (e.g. passive, dative shift, etc.) are treated as rules relating lexical items. As such, lexical entries are highly complex entities containing all of the information associated with a head that is relevant to its phonological, morphological, syntactic and semantic expression. By way of illustration we focus here on just the syntactic and semantic features of a lexical item. The typical lexical entry for a verb will contain features associated with the roles it assigns to its arguments, called CONTENT features; it will contain features associated with its superficial grammatical functions, called valence features, including SUBJ (subject), COMPS (complements), etc. Linking between CONTENT features and valence features is mediated by the ARGST (argument structure) list, which contains all of the syntactic and semantic arguments of a head. Normally, the ARGST is simply the concatenation of SUBJ and COMPS.[1] Thus, the lexical entry guides the syntax by including features regulating grammatical function as well as the interpretation by including thematic role information; and the link between those two sorts of information is ARGST.

Take for example the simplified entry for the word *give*:

1. In more complex cases involving extraction, cliticization, and other "gaps" in the syntax, the ARGST will contain information about the missing argument, linked to the CONTENT features (Manning and Sag 1999, Abeillé et al. 1998). The absence of a corresponding valence feature explains the lack of syntactic expression of the "gap".

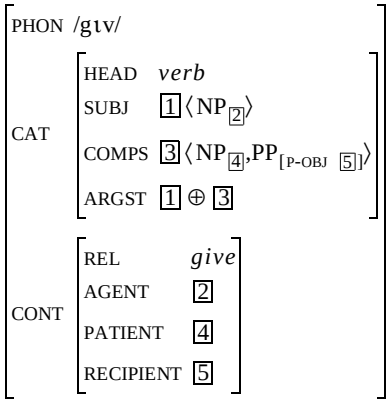

Figure (A): Lexical entry for *give*

The ARGST value is the list created by appending the values of the valence features SUBJ and COMPS. This ensures that the first argument is the subject, and the second and third arguments the direct and prepositional objects, respectively. The CONTENT features determine how those arguments are interpreted, i.e. their thematic roles. To ensure that a verb projects the right sentence structure, phrase structure schemata and the Subcategorization Principle (Pollard and Sag 1987, 1994) match the valence features to the dependents of the clause.

2.2. Lexemes and words

Sag and Wasow's (1999) categorization of lexical entries into lexemes and words provides a theoretical expression for two traditional notions of "word". A lexeme is what all of the superficially different but related words in a paradigm share; for example, *give*, *gives*, *given*, *giving*, etc., are all separate words which appear in different syntactic contexts, but there is a sense in which they are all expressions of the same basic "stem". Lexeme refers, then, to the information that all of the superficially distinct versions of *give* share. In Sag and Wasow's view each of these different versions of give is a distinct word appearing in different syntactic contexts; for example, *gives* will only appear in a sentence with a 3rd person singular subject.

Since only words can head phrasal signs, every lexeme must ultimately be related to a word or set of words in order to be used in the syntax, by means of a Lexeme-to-Word (L-to-W) rule. A typical example of an L-to-W rule is a rule that adds inflectional information to a lexeme (e.g. *give* → *gives*), in addition to the relevant phonological, morphological, syntactic and semantic

information. We will argue that an important difference between words and lexemes is that ARGST and valence features are appropriate only for the former. Linking rules determine the right correspondences between semantic arguments and ARGST at the word level. This hypothesis will be a key ingredient of our analysis.

Sag and Wasow illustrate two other types of rules. Besides L-to-W rules, there are rules that relate lexemes to each other, (our L-to-L rules); and there are rules that relate words to each other, (our W-to-W rules). Their example of an L-to-L rule is agent nominalization, which takes e.g. the lexeme *love* and creates a new related lexeme *lover*. An example of a W-to-W rule is the rule that brings about the inversion of the subject-auxiliary verb order in questions, negation, etc.[2]

The intuition behind this rule-type dichotomy is that L-to-L rules seem to affect "deeper" properties of lexical items, like lexical semantics, category, etc., while W-to-W rules seem to affect their more superficial properties, like how elements are expressed in the phrase structure. Though this intuition is not formally expressed in Sag & Wasow (1999) our approach to the distinction between the S/L alternation and DS will build on it and attempt to derive it from the basic architecture of the HPSG framework.

3. Dative Shift and the Spray/Load alternation

3.1. Our analysis

Now that the basics of HPSG and the intuition behind the two types of lexical entry have been introduced, we will outline our analysis of the DS and S/L alternation.

Dative Shift is a rule that takes a word as its input and outputs a new word--it is a W-to-W rule:

$$_{wrd}\left[\text{ARGST } \langle \boxed{1}\text{NP}, \boxed{2}\text{NP}, \text{PP}_{[\text{P-OBJ } \boxed{3}]} \rangle\right] \Rightarrow {}_{wrd}\left[\text{ARGST } \langle \boxed{1}, \text{NP}_{\boxed{3}}, \boxed{2} \rangle\right]$$

Figure (B): Dative Shift lexical rule

This rule takes a word that has three members in its ARGST (the third one being a PP) and shifts the order of the second and third members, creating a new

2. The auxiliary verb has a feature [INV] whose value can be [+] or [-]. The default [INV -] results in the auxiliary appearing after the subject in the sentence; however, a W-to-W rule takes an auxiliary with the [INV -] feature and creates a new word with the [INV +] feature. This triggers a different phrase structure schema and results in auxiliary-subject order.

word that has NP NP as its ARGST. It is merely a grammatical function changing operation on the ARGST of the word, which leaves the CONTENT features unchanged.

The Spray/Load alternation is produced by a rule that takes a lexeme as its input and outputs a new lexeme--it is an L-to-L rule:

$$lxm\left[\text{CONT}\left[\begin{array}{ll}\text{AGENT} & \boxed{1}index\\ \text{THEME} & \boxed{2}index\\ \text{LOC} & \boxed{3}index\end{array}\right]\right] \Rightarrow lxm\left[\text{CONT}\left[\begin{array}{ll}\text{AGENT} & \boxed{1}\\ \text{PATIENT} & \boxed{3}\\ \text{INSTR} & \boxed{2}\end{array}\right]\right]$$

Figure (C): Spray/Load alternation lexical rule

This rule takes a lexeme that has particular CONTENT features and creates a new lexeme with different CONTENT features. To be more specific, it turns a location argument into a patient. This rule, then, does not involve ARGST or valence features at all. Regular linking rules will provide the correct ARGST for each lexeme (Davis and Koenig 2000). Thus, in spite of a superficial similarity, the two alternations are essentially different. The similarity is that in both cases a PP alternates with an NP. The differences arise as a result of the types of lexical entries associated with each alternation. We will provide evidence for this distinction by looking at the interaction between DS and the S/L alternation with other rules of English.

3.2. Evidence for the word/lexeme distinction

We begin by outlining a number of similarities and differences between DS and the S/L alternation. We build on Baker's (1997) observation that the surface object in either alternant of the S/L alternation participates in a number of phenomena, whereas only the theme argument of DS does. Our analysis is that these phenomena are sensitive to lexemes, not words. Since there are two different lexemes associated with a S/L verb, each with a different object, both alternants may participate. Since DS is associated with only one lexeme, participation in these phenomena is limited to the theme argument. We will illustrate Baker's (1997) analysis and then our own.

The two surface objects in the S/L alternation behave alike with respect to synthetic compounds (5)-(6) and nominalized gerunds (7)-(8), but the surface objects in DS do not. Synthetic compounds and nominalized gerunds can be formed with either direct object in the S/L alternation (5) and (7) but only with the theme argument of the DS construction (6) and (8).

(5) a. varnish-spraying
b. armoire-spraying

(6) a. secret-telling
b. *spy-telling

(7) a. Her spraying of the armoire with varnish...
b. Her spraying of the varnish onto the armoire...

(8) a. His giving of a summons to the veterinarian...
b. *His giving of the veterinarian (of) a summons...

To illustrate Baker's analysis of (5)-(8) we need to outline his basic account of DS. He builds on Larson's (1988) proposal that both the NP-PP and NP-NP alternants of DS are base-generated as NP-PP. The "shift" to NP-NP is triggered if the preposition is null and cannot assign Case, forcing its object to move to a higher Case position. The VP part of a sentence like (3b), above, will have the (somewhat simplified) base-generated structure in (9a) which will then be transformed into (9b):

(9) a. $[_{VP}$ give $[_{ASPP}$ $[_{VP}$ a summons $[_{PP} \varnothing$ the veterinarian]]]] →
b. $[_{VP}$ give $[_{ASPP}$ the veterinarian$_i$ $[_{VP}$ a summons $[_{PP} \varnothing$ t_i]]]]

If the preposition is not null then the goal NP can get Case-marked *in situ*. Baker assumes that each of the S/L alternants is generated in a basic NP-PP configuration; there is no transformational relationship between the two.

Baker does not provide a full analysis of synthetic compound formation (5)-(6), though he does offer the following for (6b): "there is no room for a preposition in a simple synthetic compound." (p. 94) He relies on the hypothesized null P illustrated in (9) to rule out such compounding. His account of nominalizations (7)-(8) also relies, indirectly, on his hypothesized null P. The NP in a nominalization is normally Case-marked by an inserted inherent Case-marking preposition *of*. Inherent Case-marking is assumed to require a thematic relationship between the head noun and the marked object. On Baker's view the first object *a summons* is thematically related to the head N *giving* so *of* can inherently Case-mark that object. But the second object is thematically related to the null P, not to the head N, so inherent Case-marking fails and the second object receives no Case.

Our own analysis of the data in (5)-(8) rests on one simple claim: synthetic compounds and nominalized gerunds are lexemes. Synthetic compound formation and gerund nominalization are L-to-L rules that affect the second argument of the input lexeme:

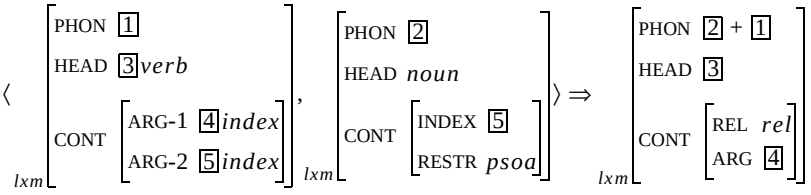

Figure (D): Synthetic compound formation

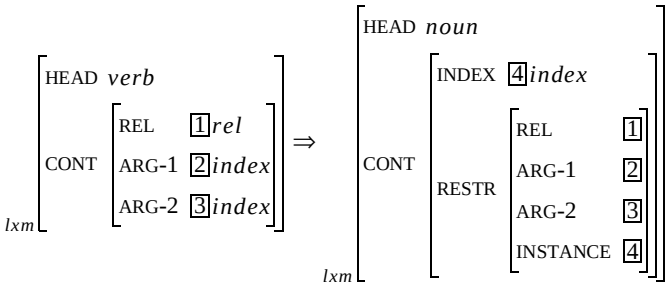

Figure (E): Gerund Nominalization

The input of the compound formation rule is a list of lexemes, corresponding to the elements of the compound.[3] The rule is only applicable to pairs of lexemes in which the nominal component corresponds to the second member of the verbal component's content. In a nominalization the type of the input lexeme is changed from verbal to nominal. At the word level, argument realization constraints specific to noun phrases will realize the second argument as the PP-*of* that appears as sister to the nominalized gerund.

Since there are two lexemes corresponding to each of the alternants in the S/L alternation, either one can be the input to these rules, accounting for the two possible forms. In the case of DS, on the other hand, there is only one lexeme, containing the theme and goal/recipient arguments. The fact that the rules affect only the second argument of the lexeme provides an explanation for why the goal/recipient argument cannot be a member of a synthetic com-

3. These rules are adaptations of Riehemann's (1997) Type-Based Derivational Morphology in which there is no independent sign corresponding to a derivational affix. A derived lexical item is a type description that includes a feature for the stem along with information specific to the derived item. In the rule notation we use here, the input corresponds to the STEM feature in Riehemann's model, the output to the sign itself minus the STEM. We have adapted her suggestion that the STEM is a list of lexemes.

pound or be realized as a PP-*of* in a nominalization. Our claim that there are two lexemes associated with *spray*, but only one associated with *give*, accounts for these contrasts in a natural way without positing otherwise unmotivated null prepositions.

In addition to the evidence that Baker provides for a distinction between DS and the S/L alternation, we add the fact that middles can be formed with the direct object of either alternant in the S/L alternation (10) but only with the theme argument of the DS construction (11).

(10) a. Coconuts load easily onto this wheelbarrow.
b. This wheelbarrow loads easily with these coconuts.

(11) a. This house shows easily to prospective buyers.
b. #Prospective buyers show this house easily.

As in the previous cases we suggest that middles are formed from lexemes. The suppression of the Agent role in middle formation is the kind of change that in our view characterizes L-to-L rules.[4] Due to space limitations we do not formalize this rule here.

Since there are two different lexemes associated with the S/L alternation, two different middles are possible (10). On the other hand, since DS involves a single lexeme, only one middle is possible, built on the theme argument (11).

3.3. More evidence: changes in meaning

Baker (1997) discusses another difference between DS and the S/L alternation. In either alternant of the S/L alternation, the surface object is an incremental theme. Verbs with incremental themes allow for a mapping of the states of the object onto the state of the event expressed by the predicate (Dowty 1991). Thus, if the object is a mass term (12a) or a bare plural (12d), i.e. if it is unbounded, then the event will be construed as being atelic (Krifka 1989, Dowty 1991)--hence the impossibility of modifying it with *in an hour*. If the direct object is bounded, on the other hand, as in (12b-c), the predicates

4. This view is contested in Stroik (1992), and Hoekstra and Roberts (1993), who argue for a syntactic analysis of middle formation, based on the hypothesis that the suppressed participant in the event expressed by the middle verb can be projected as a *for* phrase, as in, *Bureaucrats bribe easily for Sam*. But Ackema and Schoorlemmer (1995) dispute the hypothesis that the *for* phrase is an argument of the event. They also show that this claim is too strong, since not all middle verbs licence a *for* phrase. They conclude that middle formation is a 'pre-syntactic' phenomenon, which in our model translates as a L-to-L rule.

can be modified by *in an hour*, which shows that they are telic.

(12) a. John sprayed paint onto this wall for an hour/#in an hour.
b. John sprayed this wall with paint #for an hour/in an hour. (# = OK when atelic)
c. John sprayed this (whole) can of paint onto subway cars #for an hour/in an hour.
d. John sprayed subway cars with this can of paint for an hour/#in an hour.

Turning now to DS, only the theme argument is an incremental theme in either alternant. The predicate is atelic when the logical object *stories* is unbounded (13a-b), regardless of its surface grammatical relation, as evidenced by the distribution of *in an hour*.

(13) a. I have read stories to the children for an hour / #in an hour.
b. I have read the children stories for an hour / #in an hour.
c. I have read the story to children ?for an hour / in an hour.
d. I have read children the story ?for an hour / in an hour.

Baker's approach assumes that the meaning of an NP is tied to the underlying syntactic representation. There is no change in meaning between the alternants of DS because *stories* is the underlying object in all cases, but in the S/L alternation the surface object is the underlying object in each case.

Our account of this is based on the claim that only L-to-L rules can change the lexical semantics of a predicate. As argued in Rappaport and Levin (1988), the terms of the S/L alternation can express a caused change of location (when the instrument is the direct object) or a caused change of state (when the location is the direct object). In one case, the array of thematic roles of the predicate is Agent-Theme-Location, whereas in the other case it is Agent-Patient-Instrument. The argument that undergoes the change (the Theme or the Patient), which is different in each case, is construed as the incremental theme. Thus, our conclusion is that there are two lexemes associated with *spray*, but only one associated with *give*, even though there are two words associated with give. No change in the nature of the event is apparent in DS.[5]

Our approach is different from Baker's in another important way: DS is a lexical not transformational process, i.e. there are two different lexical entries associated with *give*. The familiar reasons to consider DS a lexical rule are that there are restrictions on the application of DS to verbs of caused motion, there exist exceptions to the application of the rule to verbs of transfer like *donate*, and there are verbs that idiosyncratically have only the shifted

form like *deny*.

To summarize, synthetic compound formation, gerund nominalization and middle formation are all L-to-L rules. Since words are derived from lexemes and not vice-versa an implicit ordering in which L-to-L rules precede W-to-W rules follows. The S/L alternation, then, being an L-to-L rule, interacts freely with the other L-to-L rules, but the lexical entry of the verb in the shifted construction, being a word rather than a lexeme, cannot be the input to any of the L-to-L rules. Since the shifted and the unshifted entries of a DS verb have only one lexeme in common (the one corresponding to the unshifted version), the argument in the unshifted version is the only argument that can appear in synthetic compounds, be the subject of middle sentences, or follow the preposition *of* in nominalizations. In addition, the changes in lexical semantics that are apparent in the S/L alternation but are absent from DS are characteristic of L-to-L rules. A model with two different types of lexical rules, L-to-L rules and W-to-W rules, can straightforwardly account for the differences between the S/L alternation and DS within a strictly lexicalist approach to diathesis alternations.

4. Theoretical and empirical consequences

We have argued that the S/L alternation and DS are qualitatively different types of rules. We characterized them as rules relating different types of lexical items; the S/L alternation relates lexemes; DS relates words. In this section we outline how this dichotomy of rule types can explain the qualitative differences between the two constructions.

Rules like the S/L alternation can affect the lexical semantics, lexical category, etc., of a lexical item, but only indirectly affect their grammatical functions. That is, the L-to-L rule we provided in Figure (B) manipulates CONTENT features but says nothing about ARGST and valence features; the relevant ARGST and valence features will be filled in by a general linking algorithm which relates arrays of CONTENT features with particular ARGST features (Davis and Koenig 2000). To explain why L-to-L rules affect CONTENT features but not ARGST features we propose that CONTENT features are appropriate for lexemes, but ARGST features are not. ARGST features, we

5. Green 1974, Oehrle 1976, Pinker 1989, Jackendoff 1990, Goldberg 1995, among others, use these facts to argue that there is a change in thematic role assignment between the two alternants in DS. More specifically, they argue that in the shifted construction the first NP is more "affected" than the corresponding dative PP in the unshifted alternant. This change in meaning, however, does not seem to derive from a change in the nature of the event, or in the essential properties of the thematic roles, as Baker's examples show. Thus, we follow Baker's (1997) claim that only in the S/L alternation is the meaning shift a matter of lexical semantics.

claim, are appropriate for words; the regular linking of a lexeme's CONTENT features to the correct ARGST features is a result of the L-to-W rule that creates a word from the lexeme. If lexemes are not defined for ARGST features then no L-to-L rule will be able to manipulate ARGST features.

To take an example, we propose that the lexeme *spray* will have lexical category and CONTENT features but not ARGST (or valence features). Any rule with that lexeme as its input will only be able to manipulate those features it has; one such rule is our S/L alternation: as an L-to-L rule it affects CONTENT features only. An L-to-W rule will take the lexeme *spray* and relate it to its various superficial forms, e.g. *sprays*, *sprayed*, etc. Words are defined for ARGST so the linking from CONTENT features to ARGST features takes place at that level.

A consequence of the proposal that words and not lexemes have ARGST features is that only rules that relate words can manipulate ARGST features. The DS rule in Figure (B) does just that. This rule specifically targets a lexical item –a word– with a particular type of ARGST, outputting a new word with a different ARGST.

Another fact that we want to capture is that rules like DS, while manipulating ARGST features, never seem to affect the lexical semantics of a lexical item. This would follow if W-to-W rules could affect ARGST features but be prevented from affecting CONTENT features. The generalization is that the CONTENT features of a lexeme <u>are</u> the CONTENT features of the associated word; that is, while the ARGST features of a word can be manipulated, the CONTENT features of any word are the CONTENT features of the lexeme it is derived from. We propose the following constraint to ensure this correspondence:[6]

$$\textit{W-to-W-rule}\colon \; _{wrd}\left[\text{CONT } \boxed{1}\right] \Rightarrow \; _{wrd}\left[\text{CONT } \boxed{1}\right]$$

Figure (F): W-to-W rule constraint

Our proposal, then, explains why L-to-L rules, like the S/L alternation, affect lexical semantics but not grammatical functions and why W-to-W rules, like DS, affect grammatical functions but not lexical semantics. This is essentially the dichotomy found by Wasow (1977), but expressed in a restrictive lexicalist framework.[7] Appropriateness conditions on the two types of lexical items–words and lexemes–make this distinction follow from the ar-

6. CONTENT features must be present at the word level because the compositional semantics of a sentence is determined in part by combining the CONTENT features of all of its words.

chitecture of the lexicon.

Baker's (1997) account of the phenomena above, on the other hand, rests on the assumption that the shifted object in dative shift contains an otherwise unmotivated null preposition, conflicting with the syntactic conditions on synthetic compound formation and nominalization, which require an NP and not a PP. We believe this misses an important generalization: the rules that distinguish DS from the S/L alternation form a natural class of rules that change the lexical semantics of the construction, that potentially affect word category, and may be highly irregular. In our analysis, this natural class is characterized as that of L-to-L rules. The prediction this account makes is that there will be no contrast between the S/L alternation and DS with respect to rules which do not have the characteristic properties of L-to-L rules. This prediction is fulfilled in the case of passivization, a W-to-W rule. This is why the surface object of either alternant in DS or the S/L alternation can passivize.

(14) a. The wheelbarrow was loaded with coconuts.
b. The coconuts were loaded into the wheelbarrow.

(15) a. A summons was given to the veterinarian.
b. The veterinarian was given a summons.

This correlation follows from our analysis without recourse to the hypothesized null prepositions of Baker's account.

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7. Wasow (1981), Ackerman (1992), and Copestake and Briscoe (1999) all tackle the question of how to allow different rule-types in a lexicalist framework, though they do not exploit the lexeme vs. word dichotomy proposed here.

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