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ABSTRACT

Prepositions and Verbs in the Syntax and the Lexicon

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Natural languages provide structures for predication. Predication minimally involves a predicate (the verb) and a number of arguments. The number of arguments that a verb co-occurs with defines one of its primary characteristics: transitivity. In much of contemporary linguistic theory, the structural relationship between a verb and its external and internal argument(s) is generally consistent across verbs of all types (e.g, process verbs, activity verbs, *inter alia*). Syntactic operations and critical relations (e.g, case and theta roles) are therefore mediated for every verb in the same way. In other words, internal arguments will always originate with the same structural relationship to the verb, as will external arguments, and they will always receive case and theta roles in the same way, all else being equal.

This dissertation concerns a class of verbs in which all else is not equal. Through a corpus study, it is demonstrated that a class of verbs (*exotransitive* verbs) exist where an obligatorily present internal argument is taken by a preposition. The preposition is rigidly designated by the verb, and it is argued on that basis of a sentence processing study that the verb contains all of the information about the preposition in its lexical entry. The lexical relationship between the preposition and an exotransitive verb allows for their structural assimilation to transitive verbs more broadly through a reconsideration of the structure of transitivity. The occurrence of the preposition is explained on the one hand by the contribution of its morphosyntactic features to the periphrastic verb-preposition expression, and on the other hand by an implicit association between prepositions and transitivity. This association is demonstrated with an artificial language learning experiment.

From these facts, a conception of prepositions is proposed in which prepositions are members of a distinct syntactic category in which they are primarily argument licensing functional heads. At the same time, they contain semantic content which is employed in their argument licensing uses.

Acknowledgments

As with any completed dissertation, there are a number of significant contributors whose efforts on my behalf are not otherwise evident. In my particular case, the number of individuals who deserve acknowledgment is not especially large, but the debt I owe to each of them is greater, I think, than is typical.

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The highest appreciation and acknowledgment for contributions to my professional development go to Janet Pierrehumbert and Masaya Yoshida. Their patience, their effort, and their assistance were absolutely indispensable. I learned and improved, as a researcher and otherwise, at their expense. Without their help, there is no question that I would have accomplished far less.

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and your unwavering support, I would not have survived the many years of graduate school. Truly, it is you who I owe the most to, now and forever.

To the aspiring academic who, by necessity rather than choice, goes by their middle name rather than their perfectly usable first name.

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CHAPTER 1

Introduction

1.1 A Puzzle about Transitivity

The focal point of this dissertation is a class of English verbs that do not conform to the received understanding of transitivity. Traditionally, the verb selects or otherwise associates syntactically with the direct object, with the aid of functional structure. This view is found in various forms in Hale and Keyser (1993), Chomsky (1995), and Bowers (2002), *inter alia*. However, not all apparently transitive verbs associate syntactically way with the direct object. Instead, prepositions are employed for that purpose. Consider the following examples:

(1) a. Clancy *gravitated to* the cookies.

b. Afterward the guests will *partake of* our world famous cider.

c. Steve *relies on* public transportation.

Compare them with the prototypically transitive verbs shown in (2).

(2) a. Evan hit the tree with his car.

b. The sheriff imprisoned the bank robbers.

c. The accident injured some passengers.

Unlike the transitive verbs in (2), the verbs in (1) above co-occur with a preposition. Notably, the preposition is obligatory.

(3) a. Clancy gravitated *(to)[1] the cookies.

b. Afterward the guests will partake *(of) our world famous cider.

c. Steve relies *(on) public transportation.

[1]According to convention, an asterisk (*) prior to parentheses denoting optionality indicates the ill-formedness of the optionality, and hence that a string is not well-formed without what is contained in the parentheses. An asterisk contained within parentheses denoting optionality indicates that a string is not well-formed *if* it contains what is contained in the parentheses.

The verbs in (1) are therefore distinguished from transitive verbs in requiring a designated preposition. In theoretical terms, the difference between transitive verbs and the verbs in (1) is that the preposition licenses the NP complement. I will use the term *license* in the following way throughout this dissertation:

LICENSING: A head α licenses a head β if α determines the occurrence of β.

The notion of licensing is related to the concept of arguments. Items traditionally known as "subject", "object" and "indirect object" - the latter being particularly identified with PPs - are all arguments. The definition that I will use is given below.

An ARGUMENT is a head or phrase that satisfies the requirement of a licenser.

This dissertation is concerned mainly with *verbal* arguments, and the term will be conflated for the sake of conciseness from here on. In that context, the term *argument* will be preferred to terms like "subject" and "direct object" throughout this dissertation, except where the neutral quality of subject/direct object is useful.

Seen in light of the notions of licensing and arguments, the difference between verbs like *gravitate*, *rely*, and *partake*, and transitive verbs can be recast in theoretical terms. Transitive verbs license their arguments, while verbs like *gravitate*, *rely* and *partake* occur with some preposition which licenses an argument (assuming for now that the complement of the preposition is an argument of the verb). It is possible, for example, that the PPs in (1) could be adjuncts, which would render the comparison to transitive verbs irrelevant. Alternatively, the PPs could be the complement of the verb, which would make them more like transitive verbs because the complement of the verb is an argument position with transitive verbs. In that case, it would appear that the preposition is taking the argument of the verb.

Constituency tests confirm that the PP is the complement of the verb. The pseudoclefting test (4) demonstrates that the PP must move along with the verb. The substitution test (5a-b) show that substitution of the verb and PP is possible by VP and verbal proforms, but substitution of the PP by prepositional proforms is not (5b). The uniqueness of the verb-preposition combination is also underscored by the fact that coordination is possible with VPs but the PP cannot be coordinated with other PPs (6).

(4) Pseudoclefting

a. Gravitate to the cookies is what Clancy did.

b. * Gravitate is what Clancy did to the cookies.

(5) Substitution

a. Marge gravitated to the cookies and Clancy did so too.

b. ? Marge gravitated to the cookies and Clancy did so to the punch.

c. * Marge gravitated to the cookies and Clancy gravitated there.

(6) Coordination

a. Steve [$_{CoordP}$ [$_{VP}$ gravitated to the punch bowl] [$_{Coord}$ and [$_{VP}$ bumped into a passing waiter.]]]

b. * Steve gravitated [$_{CoordP}$ [$_{PP}$ to the punch bowl] [$_{Coord}$ and [$_{PP}$ at the table.][2]]]

Two further tests demonstrate that they are not adjuncts. First, they fail the omissability test. Contrast ill-formed exotransitives (7a-b) with well-formed examples of omissible adjuncts (7c-d). The omissibility test works because, while certain arguments and also adjuncts can be omitted, if something *cannot* be omitted, then it must be an argument (Williams 2015).

(7) Omissibility

a. * Everyone relies.

b. * Clancy gravitated.

c. Everyone relies on Tyler (in the morning).

d. Clancy gravitated to the punch bowl (after his speech).

Second, they also fail the iterability test. If a constituent can be iterated, then it is an adjunct, because there is a one-to-one correspondence between thematic roles and arguments (Williams 2015). There is some difficulty in applying the test in certain cases, because some contrast is typically required for iterability to be felicitous. In (8a-b), each preposition that occurs with the verb is one that can also occur as an argument with the verb, thereby providing some contrast. The examples are nonetheless not well-formed. Contrast (8a-b) with well-formed examples of iterated adjuncts (8c-d).

(8) Iterability

a. * Everyone relies on neighbors upon friends.

b. * Clancy gravitated to the cookies towards the table.

c. Nobody likes to rest in New York on a bench.

[2]There is perhaps a marginal adjunct reading here, where the second conjunct is actually elliptical with a topic-dropped PP. In that reading, *at the table* is a locative adjunct. That reading is irrelevant, given the annotated structure is coordinated PPs.

d. Clancy gave a speech at 8 o'clock before the dinner.

At the same time, the PP can be dislocated from the verb in a variety of ways. This shows that the verb and the PP are distinct elements morphologically and syntactically. (9a) shows dislocation by fronting, (9b) dislocation by an intervening PP, and finally (9c) dislocation by clefting.

(9) a. To the cookies Clancy gravitated.

b. Afterward the guests will partake for about an hour of our world famous cider

c. It is on public transportation that Steve relies.

The examples in (9) are somewhat stylistically marked, but they are nonetheless possible. In sum, then, a variety of tests conclusively identify the PP as an argument. To understand what this means, consider the definitions below.

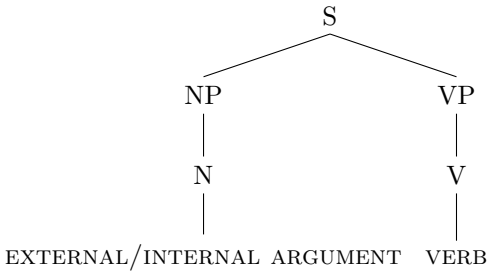
- Transitivity is a property that describes the number of co-occurring arguments and information about their order.
- A verb is
  - Intransitive if it co-occurs with one and only one argument.
  - Transitive if it co-occurs with two arguments.
  - Ditransitive if it co-occurs with three arguments.

Given the preceding definitions, it follows that verbs like *gravitate*, *rely*, and *partake* are genuinely transitive. They necessarily co-occur with two arguments. This is also true, naturally, of all transitive verbs which do not make use of prepositions. However, unlike transitive verbs more broadly, verbs like *gravitate*, *rely* and *partake* do not license the complement of the preposition directly or apparently associate with it syntactically in any way. I will henceforth refer to these verbs as *exotransitive* verbs, since they are transitive outside of their own phrase. How exotransitive verbs fit in to contemporary syntactic and semantic theory is the central question of this dissertation. Particular attention will fall on the contribution of the preposition.

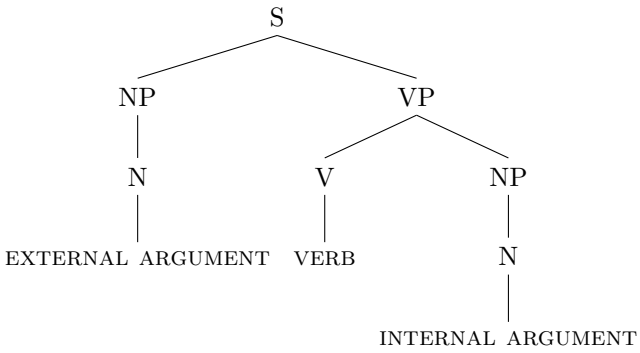
Much effort has been expended to understand the similarities and differences between verbs according to the number of arguments they occur with. This includes the prominent case of ditransitive verbs, which almost always make use of a prepositional argument. From Baker (1988)'s UTAH to constructionist approaches like Goldberg (1995), it is widely accepted that verbs within each category are structurally similar

to each other.[3] Although the details differ across formalisms, the generalized structures of the verb types are given in (10), in phrase-structure form.

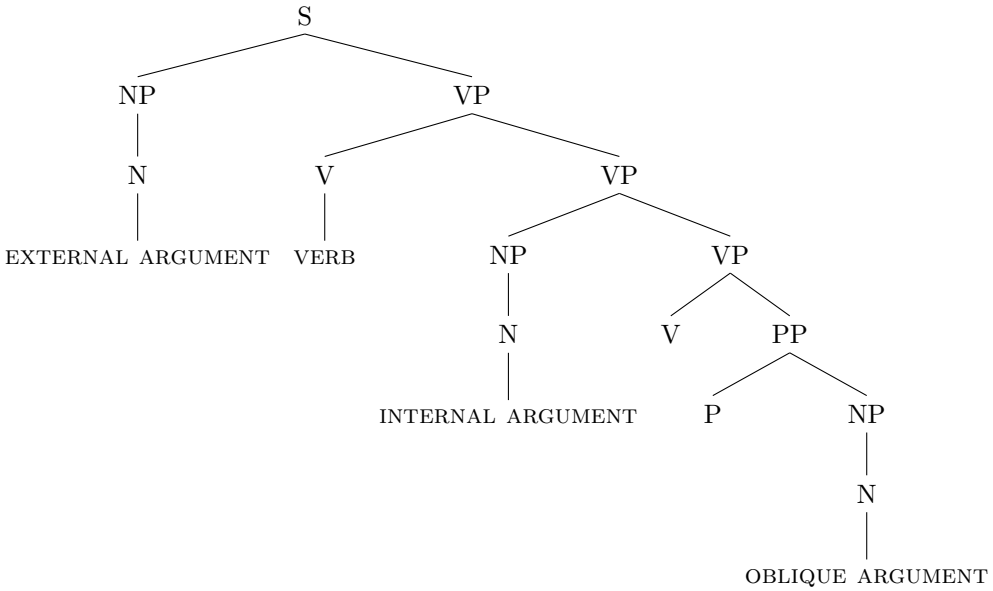
(10) a. **Intransitive**



b. **Transitive**



c. **Ditransitive**



All types of verb may have external arguments. External arguments are the most structurally remote

[3]This is naturally a simplification (ignoring, for example, the structural differences between ergative and unaccusative intransitives) but it will suffice for the moment to pass over the details.

argument from the verb. They are preverbal in English, and typically identified with the subject. What distinguishes (10a) from (10b-c) is the presence of a postverbal internal argument. Internal arguments are licensed within the VP and originate structurally within it as well (Hale & Keyser 1993)[4]. The difference between transitive verbs and ditransitive verbs is the presence of an oblique object (itself an internal argument of a kind), which is taken by a preposition.

Oblique objects are the most well-known cases of interactions between prepositions and argument structure/verbal valence. Even in those cases, however, the critical questions are so rarely asked. These are: why and how is there a preposition? What is it doing, exactly, and how does it do it? No answer to these questions is known. Part of the problem is that prepositions and transitivity bear little obvious relationship to one another. Prepositions may occur with arguments as complements, but they may also be adjuncts instead. Transitivity itself is concerned only with the number of arguments, not whether they are prepositional or nominal.

As always, however, the devil is in the details. Prepositions and verbs interact far more in the service of transitivity than is often supposed. Their influence surfaces in everything from argument structure alternations to valence-changing operations. Evidence will be advanced that speakers represent certain verbs and prepositions jointly in the lexicon. Even more acutely, there will be a demonstration that speakers implicitly associate prepositions with verbal valence by displaying a strong bias for prepositions to mark transitivity over intransitivity.

I will put forth a complete analysis of prepositions and verbs in English, with particular focus on their interactions in service of transitivity. I will provide analyses for individual constructions as well as in broader theoretical terms. The analysis will stretch across the lexicon, syntax, semantics, and their interfaces, using corpus and psycholinguistic methods in addition to theoretical argumentation. It is only by seriously scrutinizing the relationship between prepositions and transitivity with multiple methodologies that a true advance in understanding can take place. At its most basic, this dissertation is an attempt at that.

1.2 Exotransitivity and Transitivity

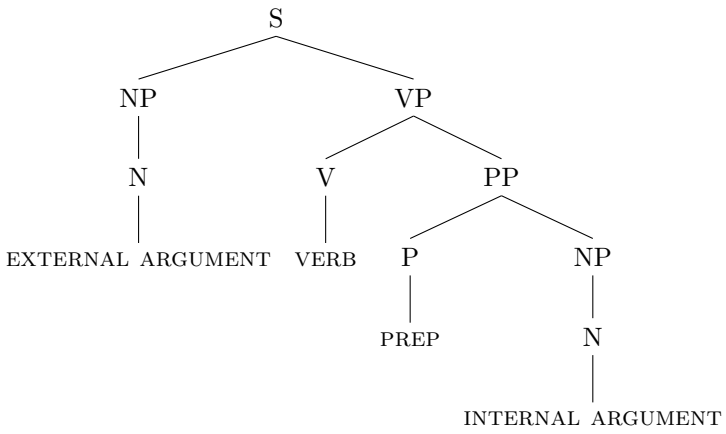
In the simplest respect, the difference between exotransitives and other transitives is the obligatory presence of a rigidly designated[5] preposition. In contrast to the generalized structure of transitive verbs (10b), exotransitives necessarily include a PP. Contrast the generalized structure of exotransitives (11) with the

[4]With the preverbal internal argument in (10a) being derived by movement in unaccusatives.

[5]This is a temporary simplification; some exotransitive verbs like *depend on* have flexibility, permitting related *depend upon* and so forth. Even so, the inventory is very small and always semantically related.

one of transitives (10b).

(11)



Representationally, the difference is just the presence of the PP. This is a fairly superficial difference in some respects. Mechanically, however, the difference is far more significant. The differences comes down to licensing. Transitive verbs license the internal argument. On the other hand, exotransitives license a preposition which in turn licenses the internal argument. I will refer to verbs that license their direct object as *simple* transitive verbs to distinguish them from exotransitives.

Recall the definition of transitivity: a verb is transitive if it co-occurs with two arguments. Simple transitives fit this definition by occurring with an external argument and licensing their internal arguments. Exotransitives meet this definition as well, but they do so by occurring with an external argument and having their internal argument licensed by a preposition. Exotransitive verbs are, then, a subtype of transitive verb along with simple transitives.

Is it enough to simply state the existence of subtypes of transitive verb? In other words, can exotransitives be satisfactorily placed within a theory of transitivity by asserting the existence of minor variations on a generalized transitive structure that includes both simple transitives and exotransitives? After all, there are many recognized semantic types of transitive and intransitive verbs, and no attendant problems with such classification. There are even salient variations on transitive verbs, like particle verbs.

(12) a. The children ate the ice cream.

b. The children ate up the ice cream/the ice cream up.

There is no change in licensing induced by the optional occurrence of a particle or the different orderings. In that sense, there is nothing especially different in syntactic terms about particle verbs or other variations

on simple transitives.

However, this avenue of explanation is not open. Unlike minor variations such as particles, exotransitives and simple transitives differ in how licensing is accomplished. This difference is far more significant both mechanically and theoretically than minor variations. The number of arguments that a verb may occur with is perhaps its most salient property. Verbs are commonly thought to be responsible for the theta roles of the arguments, and case assignment to the internal argument (Marantz 1984). Verbs also exert semantic-selectional influences on their complements (Grimshaw 1979). If the responsibility for licensing is stripped away from a verb, so also apparently must go the influence it exerts. This leaves a significant vacuum in the derivation: if not the verb, then who - if not by the verb, then how? It is therefore not enough to just define two subgroups of transitive verbs, when they are so radically different.

It is tempting to simply say instead that exotransitives are some aberrant manifestation of a simple transitive. The essence of this thinking is that the preposition is in some way ignored or inert. Its phrasal structure is used as a channel by the verb to perform whatever operations the verb normally must on any object it would license. In this way, an exotransitive verb reaches into the PP and treats the preposition's object exactly as if it were the its own.[6][7]

This might seem a reasonable option but for the fact that it violates several foundational principles of generative grammar. The first is the Locality of Selection. I give Sportiche, Koopman and Stabler (2014)'s definition.

> Locality of selection: If a head α selects β, β appears as the complement, subject, or adjunct of α.

Since the object of the preposition is contained within the PP, it cannot be the complement, subject, or adjunct of the verb. Indeed, it can have no particular relationship to the verb without movement (other than c-command). The verb therefore cannot correspondingly exert any selectional or licensing influence over the preposition's complement. To get around this, it might be supposed that the preposition is effectively an extension of the verb. That way, the object of the preposition could be brought under the influence of the verb. But doing this violates the Single-headedness Principle. I use Williams (2015)'s formulation of the principle, given below.

> the single-headedness principle: Phrases have one and only one head.

[6] However this might be done. Since I do not wish to risk assassinating a straw man, I will not imagine any scenarios of this kind.

[7] This idea undoubtedly bears some resemblance to "reanalysis" *a la* Horstein and Weinberg (1981). I must emphasize I am not identifying or promoting any particular proposal or analysis here, however.

In making the preposition an extension of the verb such that the verb can exert a selectional influence on the object of the preposition, the preposition would have to be a kind of verbal head that somehow extends the verb phrase below it[8]. As such, both the verb and the preposition would be heads of one and the same VP. A violation of the Single-headedness principle ensues.

Making the preposition a channel for the verb's influence is also potentially problematic for endocentricity. Endocentricity is central to multiple approaches to grammar, including Minimalism, HPSG and LFG. The principle, broadly stated, is the following.

ENDOCENTRICITY: A phrase has the same category as its head.

While the VP and PP would technically be separate, the PP structure would be a VP for all intents and purposes. The verb would be using it for its own purposes, while the preposition would be doing effectively nothing. As a result, the character of the PP would be inconsistent with the category information of the head. This would violate endocentricity in the process. Given that violations of foundational principles are attendant to any attempts to naively assimilate exotransitive verbs to simple transitives, the right approach is most probably not in seeking to assimilate one to the other, or to some other existing phenomenon. There are nevertheless more nuanced assimilatory possibilities that will be addressed in the forthcoming chapters.

A unified understanding of transitive verbs is essential to a theory of natural language syntax and semantics. As a concept, transitivity is critical to understanding verbal syntax and meaning. Secondarily, transitivity relates to phenomena like word learning, causativity, ergativity, and a number of others. The correct classification of transitive verbs and their common properties precedes the understanding of transitivity as a concept. Unifying exotransitives with transitives is a necessary precursor to applying the notion of transitivity completely in English and perhaps beyond. This is to say nothing of the benefit of an increased understanding of prepositions that would arise from a thorough examination of exotransitive verbs. Polar opposite opinions on the nature of prepositions are regularly offered in the literature (Grimshaw 2000; Croft 1991; Jacobs & Rosenbaum 168; Baker 2003; Den Dikken 2003; Muysken 2008; Pesetsky & Torrego 2002; Asbury 2005; Luuk 2013; Hagège 2010).

Exotransitives and simple transitives therefore must be unified structurally and semantically, in which they accomplish licensing in the same way. There are at this point two broad ways to unify them. One is to distill exotransitives and transitives into their components and extract the most basic similarities between the two. From there, a synthesis can be affected. Another way is to assimilate exotransitives to some existing

[8]Rather than above it, in the typical fashion of an extended projection.

phenomenon, where exotransitives are some peculiar manifestation of something otherwise well-understood. The former approach I will call the *synthetic* approach, the latter, the *assimlation* approach. For reasons that will become clear, I will be taking the synthetic approach in this dissertation. A portion of Chapter 2 will be dedicated to arguing against certain assimilation approaches. The remainder of the content here is devoted to outlining the synthetic solution to be pursued.

1.3 A Synthetic Unification of Transitivity

In the theory transitivity that I will employ, known as exoskeletal syntax (Borer 2005a; Borer 2005b), no verbs license their internal arguments: they neither license them in the syntax nor introduce them into the semantics at the syntax-semantics interface. Transitivity is still a verbal property, in the sense that the number of arguments a verb occurs with is still constrained by what functional elements occur with it, like the preposition. But the explicit task of licensing the argument is up to another element. In exotransitives, this is the preposition. In simple transitives, it is another head whose properties will be enumerated in a later chapter.

Absolving the verb of responsibility for licensing the internal argument makes exotransitives and transitives congruent on that dimension. Neither exotransitives nor transitives license their internal argument. At the same time, it opens up another question of why some transitive verbs use a preposition and why others do not. I will argue that the difference between exotransitive verbs which use prepositions and simple transitive verbs has to do with observable differences between null and prepositional complements. Consider the pair in(13-14) below.

(13) a. The boy kicked the ball.

b. The boy kicked at the ball.

(14) a. Tom read the Vedas.

b. Tom read of the Vedas.

The pair in (13) differs in the affectedness of the theme *the ball*. With the preposition, it is unaffected; without it, it is fully affected. The pair in (14) exhibits a difference in directness and completeness of experience. In (14a), *Tom* has read *the Vedas* and knows their complete content firsthand. In (14b) by contrast, *Tom* only knows about *the Vedas* secondhand, and he knows them incompletely. These meanings (unaffected themes and indirect experience) also manifest in exotransitive verbs with these particular prepositions.

(15) a. The boy gazed at the ball.

b. Tom partook of the feast.

In (15a), the action taken by *the boy* has no effect on *the ball*. In (15b), *Tom* has eaten some of the food available, but not all of it, indicating incomplete experience. Both meanings mirror the ones of (13-14).

The meanings of some internal arguments are better fit by a preposition and its accompanying meanings than no preposition. These differences will be discussed in more depth, but for now it is sufficient to say that these theoretical moves can unify exotransitive verbs with transitive verbs in the syntax. They can be unified in the lexicon if both specify the need for the functional structure that licenses the internal argument. So while neither exotransitives nor simple transitives license their internal arguments directly, both specify members of another category in every case that will license the internal argument. This approach violates neither single-headedness nor endocentricity. The verb and functional head are two separate heads; their structure and functions are separate but complementary.

Lastly, to affect a complete unification, the syntax-semantics interface needs to be able to interpret the internal arguments of both simple transitives and exotransitive verbs in the same way, and with the same inventory of thematic roles. The internal argument is introduced in the semantics by the preposition. The preposition itself needs to be a interpreted as an argument-introducing thematic predicate at the interface. As I will show, this results in a semantic representation that is equivalent to that of a simple transitive verb.

The analysis of exotransitives here developed has consequences for the understanding of licensing and argument structure in ways that have already been outlined. Beyond that, significant conclusions will be drawn about prepositions as a category. Prepositions are critical to understanding exotransitives, and so significant effort will be invested in understanding what they are and what they do. The picture of prepositions that emerges from this dissertation is multifaceted. In Chapters 4 and 6, psycholingustic evidence will be introduced that prepositions and verbs are significantly related in speakers' knowledge of English. Chapter 4 will show in sentence processing experiments that speakers have knowledge of prepositions associated with verbs at the point of processing the verb. This indicates that verbs and prepositions are represented together during online processing, which argues for a kind of joint lexical representation.

More significantly, however, I will argue that prepositions are more deeply related to transitivity than just a lexical association with verbs. English speakers may in fact have a bias to associate prepositions with transitivity alternations. This is not surprising from the analysis of exotransitives, but it is nonetheless striking. As I demonstrate, English speakers by default associate prepositions with transitivity, even when a statistical cue goes in the opposite direction. Learners demonstrate an asymmetric bias, preferring to

associate prepositions with intransitivity rather than the opposite, regardless of the statistical distribution of the input. I demonstrate this with a series of artificial language experiments, and back up the conclusions by modeling the results with the Double Sigmoid Scaling model (Schumacher & Pierrehumbert 2017).

1.4 Methodological Note

Before continuing, it is necessary to provide a methodological note concerning the kind of analysis to be pursued and especially its representational character. In terms of representation, I adopt a Minimalist framework (Chomsky 1995). This is largely for its broad familiarity rather than any particular substance; wherever possible, the insights will be couched in theory-neutral terms, since the object of investigation requires serious consideration by all frameworks. When this is not possible, I endeavor to make the translation of serious theoretical issues into different frameworks as straightforward as possible.

Having made my goals clear, it is necessary to make explicit exactly what prescriptions I will be importing from Minimalism. In particular, I will assume a binary-branching, phrase-structure model of syntactic representation (Chomsky 1995). Every string that is syntactically well-formed is spelled out to a phonological representation called Phonological Form (PF) and to a Logical Form (LF), a representation that constitutes part of the syntax-semantics interface. Only LF will be relevant going forward. I will also assume the existence of a lexicon composed of memory traces of words and their associated phonological, syntactic and semantic information. Included in lexical entries are generative primitives such as case, theta roles, and selectional specifications wrote in morphosyntactic features. To that end, when representing lexical items, I will use HPSG-like attribute-value matrices rather than more typically Minimalist valued feature lists for the sake of explicitness.

1.5 Structure of the Dissertation

The structure of this dissertation is as follows. Chapter 2 establishes that exotransitives are a real class of English verbs with a corpus study. They are not explained by relatively simple mechanisms like selection or compounding. They are a real and actual class of verbs with similar and consistent features. The second purpose is to consider and reject remaining assimilatory proposals. At the conclusion of Chapter 2, it will be clear that exotransitives are a class of transitive English verbs that is its own phenomenon in need of explanation.

Chapter 3 begins with a justification of the synthetic approach. Following that, I argue that the key

to understanding exotransitives is understanding prepositions. In other words, to make progress in understanding exotransitives, it is necessary to better understand the respect in which they are most different from simple transitives: the preposition. To that end, the remainder of the chapter reviews the existing understanding of prepositions and treatments of exotransitive verbs.

The aim of Chapter 4 is to elucidate the nature of the association between exotransitive verbs and their prepositions. The nature of that association - which is argued to be lexical - is be relevant to the analysis of exotransitive verbs. I present the results of two sentence processing experiments that demonstrate that the lexical entries of exotransitive verbs contain specific information about their preposition, which can be leveraged in real time. From this I argue that the lexical representation of exotransitive verbs is structured in such a way as to include the corresponding preposition.

Chapter 5 presents a syntactic and semantic analysis of transitives. I argue for a synthesis of exotransitives and simple transitives by proposing that neither take any arguments (neither internal nor external). Using a model of phrase structure syntax known as exo-skeletal syntax (Borer 2005), I show that neither simple transitives nor exotransitives license their internal arguments. Exotransitives have their internal arguments licensed by prepositions. Next, the syntactic unification of simple transitives and exotransitives is applied to the syntax-semantics interface. I propose that exotransitives and simple transitives are the same at the interface according to full thematic separation.

In Chapter 6, the question of the prepositional nature of licensing found in exotransitives is taken up. With an artificial language learning paradigm, I demonstrate that English speakers possess a bias to associate prepositions with transitivity, regardless of the statistical distribution of the input. This shows that there is a deep and possibly highly abstract relationship between prepositions and transitivity that uniquely singles them out for the purpose of argument licensing with verbs.

Chapter 7 begins by summarizing the analysis of exotransitives, highlighting the way in which the analysis of exotransitives provides insight into the nature of verb and preposition relationships generally. The generality of the analysis is established by extending it to other cases of prepositions in English, beginning first with other argument prepositions, then to adjuncts, and finally to nominal uses. The chapter concludes with remarks on prepositions as a category, picking up unresolved issues from the review in Chapter 3. Chapter 8 summarizes and concludes.

CHAPTER 2

Exotransitives are a Verbal Class

2.1 Motivation & Criteria

The first step in my argument is to establish exotransitive verbs are a class with consistent properties across its members. Without that established, there is little justification for a synthetic approach. After I demonstrate that exotransitives are a class of verbs, I will rule out remaining assimilatory proposals.

In order to establish exotransitives as a class, I must first introduce the criteria upon which that judgment can be based. The behavior of English prepositions in with respect to verbs is notably variable. Below are some examples of the different ways that prepositions and verbs may relate in English.

(16) a. Rick put the glass *(*on* the table). (obligatory argument PP)

b. Sandra donated her food (*to* the shelter). (optional third argument)

c. Kyle and Rita met (*with* the headmaster). (optional internal argument)

d. The youth kicked (*at*) the ball. (alternating internal argument)

e. The plan depended *(*upon*) some masterful maneuvers. (obligatory internal argument)

f. She read her book (*in* the park). (optional non-argument)

g. The bill was passed (*by* a bipartisan coalition). (optional voice-dependent argument).

Each of the examples (16a-g) represent different ways that prepositions and verbs may be related. Roughly two dimensions are at play in classifying the different ways the prepositions and verbs are related. The first is obligatoriness: is the prepositional dependent obligatory, or is it optional? The second is whether the prepositional dependent is the internal argument, or an (oblique) argument. Linear distance in this case will serve as a proxy for internal argumenthood.

It is these two properties that I will use to demonstrate that exotransitives are a class all their own. Obligatoriness and distance are highly relevant for classifying verbs as transitive or intransitive. The omissibility test for argumenthood (Williams 2015) works because only arguments can be obligatory. While it is true that some arguments are not obligatory, it is true that if something is obligatory, it must be an argument.

By examining the obligatoriness of the prepositional dependent of exotransitives, it can be concluded that they are arguments. Distance in this case is a good proxy for structural relationship. If the prepositional dependent is always adjacent to the verb and it is also obligatory, the only possible conclusion is that it is an internal argument. The same properties are true of the objects of simple transitives: they are adjacent to the verb, and they are obligatory. The method I will use to demonstrate that the prepositional dependent of exotransitives is an obligatory internal argument is a corpus study.

2.2 Establishing Exotransitives as a Class

The corpus study will focus mainly on three types of verbs from among those shown in (16). One is exotransitives (16a). The two other types are the verbs which are matched with exotransitives on one of the two dimensions: distance and obligatoriness. Verbs which match exotransitives on the dimension of distance I will call *alternating* verbs. Alternating verbs alternate between co-occurring with PPs locally, and not taking them. This class is somewhat heterogenous. It includes verbs which alternate between taking no internal argument at all or a prepositional argument (16c) (∅/PP alternating), as well as verbs which take complements of other categories alongside a prepositional one. Complements of at two types, NPs (NP/PP alternating) and CPs (CP/PP alternating) are also possible as alternating verbs. Examples of these latter types include *kick* as in (16d) and *inquire if/after*.[1]

The other class for comparison are those which take oblique third arguments. This is a familiar group, subsuming ditransitives among others. I will call this class the *obligatory* verbs because the oblique argument may always be present. This is true even if it is not expressed by overt material. So for example, *donate* does not need a PP expressing the indirect object, but any event of donating logically must have a recipient to be well-formed.

Alternating and obligatory verbs serve as good comparisons for the critical properties that define exotransitives. Alternating verbs are cases of prepositions heading what are apparently internal arguments (because of their short distance). The extent to which exotransitives and alternating verbs share short distances between the PP and verb argues for their (dis)similarity. For example, it is not typical for internal NP arguments of verbs to be separated from the verb itself (Johnson 1991). Consider the examples below (17a-b). With certain alternating verbs, this difficulty is mirrored (17c-d).

(17) a. The vizier conceived the plot with relish.

[1]It is worth nothing that CP/NP/PP alternating verbs do exist, but only rarely, like the verb *believe*. I will not distinguish these verbs in any significant way in the forthcoming analysis.

b. ?? The vizier conceived with relish the plot.

c. The vizier conceived of the plot with relish.

d. ? The vizier conceived with relish of the plot.

(17b,d) are both possible with focal prosody on *with relish*, and their deviance is not equivalent (17b is worse than 17d) but both are definitely worse than their correspondents (17a,c) where the verb-internal object sequence is not broken up. Internal NP arguments tolerate distance from the verb less than PP arguments with alternating verbs. So if exotransitives show lower linear distance than the PP argument of alternating verbs, then they are more like NP internal arguments. Furthermore, it would show that exotransitives are not just "unalternating" members of the alternating class. Ideally, then, exotransitives should have lower linear distances than alternating verbs, and they should also have significantly higher co-occurrences of preposition and verb due to the obligatoriness of the prepositional dependent.

Obligatory verbs are good comparisons for the other dimension, obligatoriness. There is a substantial class of 3-place English verbs that occur with prepositions of all kinds. These verbs take their prepositional dependents reliably. Some examples are given below.

(18) a. That lifestyle availed him *(of many opportunities).

b. The statistician attributed the errors *(to faulty data collection).

c. The storyteller regaled them *(with ghost stories).

In Chapter 1, I asserted that exotransitives take their prepositional dependents obligatorily. In theory, the same reliability of co-occurrence is mirrored in obligatory verbs. The degree to which the prepositional dependent of exotransitives is obligatory can be understood by comparing it with the rate of occurrence for obligatory verbs. Ideally, the rate of occurrence will be higher in exotransitives. Were that the case, it would argue that exotransitives are not just obligatory verbs that lack an NP argument for whatever reason. Furthermore, the obligatoriness with exotransitives should also be roughly equivalent to NP objects.

If exotransitives have lower distances than alternating verbs, and also exceed obligatory verbs with regard to preposition co-occurrence, then realistically they should be considered a separate class from both. If their distance and co-occurrence is comparable to simple transitive verbs, then the comparison of the prepositional dependent and the NP argument of transitive verbs is better supported. I will address all of these comparisons in the following study.

2.3 Design of the Study

2.3.1 The Candidate Set

The British National Corpus (BNC) was searched for occurrences of a set of candidate verbs belonging to each of the types described in the preceding section. Candidate verbs for each of the different verb types were selected in a two part process. First, every verb in the Oxford Phrasal Verbs Dictionary that included a prepositional collocate was classified as one of these types. Second, several thesauri were consulted for related exotransitive verbs. The criteria for classification as one of the verb types were based on the logical properties of these verbs. Thus, even though it is much more frequent for the verb *coincide* to take the preposition *with* as in *The festival coincided with the solstice*, than for it to occur with a conjoined subject (*The festival and the solstice coincided.*), *coincide* is still classified as a alternating verb. This method of classification prevents the analysis from being circular by virtue of the fact that verb classification is independent of frequency. The criteria for verb classification are given below.

- Exotransitive verbs were those determined to have only one possible complement, a PP.
  - Examples: account for, capitalize on, participate in
- Alternating verbs were those that could occur with a specific preposition **or** without one. It might take instead a NP, a clausal complement, or no complement, but never would these other possibilities co-occur with the prepositional collocate with the same interpretation as if it were alone with the verb.
  - Examples: pronounce NP/on, testify CP/to, wrestle ∅/with
- Obligatory verbs are those that may take a specific PP as their third argument.
  - Examples: ascribe NP to, budget NP for, compare NP with

The list of candidates was trimmed according to frequency with the lower bound at 300 occurrences. The resultant list of verbs included 168 verbs total, 38% of them exotransitive, 27% alternating, and the remaining 35% obligatory. The full list of the candidate verbs is given in Appendix A.

On top of this, two more groups were added. The first was a list of every verb with over 300 occurrences in the BNC. These verbs allow for a baseline comparison. They have no fixed relationship with any particular preposition, so their rate of preposition occurrence reflects a baseline rate of preposition occurrence. Every preposition type that I have introduced should differ from this group. Given the likelihood that the most

regular preposition occurrences will be as adjuncts, the average word-level distance should also be higher than for every group but obligatory.

The second group was a set of underived nominal forms of the candidate verbs. These were included, when they existed, to see the extent of preposition occurrence with nouns and how it differs between nominal and verbal form. This comparison also included how often the specified preposition occurred relative to the default nominal preposition *of*. This difference represents the strength of association between the preposition and whatever meaning units are common to the verbal and nominal forms. By contrasting the association strength of the preposition and verb, and then the preposition with the noun, the contribution of being specifically *verbal* can be isolated.

2.3.2 Association Measures

Association strength was described by two different measures: pointwise mutual information (PMI, Church and Hanks 1990) and likelihood ratio (Manning & Schutze 1999). The definition of pointwise mutual information $I(x, y)$ where x is the first collocate and y is the second is given below.

$$I(x, y) = \log_2 \frac{p(x, y)}{p(x)p(y)} \tag{2.1}$$

Mutual information relates the joint probability of x and y to the probability that they occur independently. If x and y are part of a collocation, then their joint probability would far exceed the probability of independent occurrence. In such a situation, $I(x, y)$ would be much greater than 0. The pointwise mutual information of exotransitives should be higher than for any other verb type. Though pointwise mutual information has been shown to give higher scores to low frequency events (Manning & Schutze 1999), a cutoff of 300 occurrences obviates this concern.

A second association measure recommended by Manning and Schutze (1999) is the likelihood ratio. The likelihood ratio represents how much more likely it is that the preposition and verb occur independently than that their occurrence is co-dependent. In this sense, it is an easily interpretable descriptive statistic. The likelihood test compares the following probabilities:

$$\textbf{Independence (H1)}\text{: } P(w_1 \mid w_2) = p = P(w_1 \mid \neg w_2) \tag{2}$$

$$\textbf{Non-independence (H2)}\text{: } P(w_1 \mid w_2) = p_1 \neq p_2 = P(w_1 \mid \neg w_2) \tag{3}$$

The probability of these hypotheses are given by the comparison of their binomial probabilities.

$$L(H1) = b(c_{12};\ c_1;p)b(c_2\text{-}c_{12};\ N\text{-}c_1;p) \tag{4}$$

$$L(H2) = b(c_{12};\ c_1;p_1)b(c_2;c_{12};\ N\text{-}c_1;p_2) \tag{5}$$

In the formula above, c_i represents the count of collocate i, N is the total number of words in the corpus. The expected probabilities $p,\ p_1,\ p_2$ are

$$p = \frac{c_2}{N} \quad p_1 = \frac{c_{12}}{c_1} \quad p_2 = \frac{c_2 - c_{12}}{N - c_1} \tag{6}$$

The ratio of these values is the comparison between the hypotheses of independence and non-independence.

$$log\lambda = log\ \frac{L(H1)}{L(H2)} \tag{7}$$

In practice, the higher the likelihood ratio ($log\lambda$), the greater the association between the collocates. Likelihood ratios are not as sensitive to low frequency events as PMI is, but more importantly it is a distinct and accepted way of measuring association strength. $-2log\lambda$ is also χ^2 asymptotically distributed, which provides an implicit significance threshold if desired. By using both PMI and likelihood ratio measures, it is possible to see how the measures consider the different verb types, and further if they corroborate each other.

2.3.3 Final Considerations

There are, finally, two details which deserve mention. The first concerns the search window for the collocates. A limit of twelve words was set, defined specifically starting from the verb and looking up to twelve words later for the preposition. Since preposing of the preposition can be safely neglected (due to its infrequency) and since the prepositions in question are ordered specifically after the verb, this simple window was sufficient. The search also terminated if an EOS character appeared within the window.

Second, there are some peculiarities in the set of exotransitive collocations that require explanation, especially in how they are applied. Some verbs, especially the exotransitives, show some flexibility in the type of preposition they co-occur with. Usually these variants are semantically related, like the examples given below.

(19) a. John depended on/upon Nancy.

b. The socialite gravitated to/toward(s) the center of the party.

c. The health inspectors barged in/into the kitchen.

More rarely, there appear to be pairs that have no relationship, but nonetheless every other condition for exotransitivity holds: one of the two possible prepositions must be expressed, and both cannot be. Some examples of verbs like this are *retail for / retail at* and *partake of / partake in*. I have labeled these verbs as exotransitives in the study, although they are admittedly exceptional in this regard. When two equally viable prepositions exist for a given exotransitive verb, I have chosen to count them together for purposes of the association measures.

2.4 Results

2.4.1 Verb Types Against Baseline Verbs

All of the verb types defined above were alleged to be distinct ways that prepositions and verbs relate. This means that they have an actual relationship. By contrast ubiquitous simple transitive or intransitive verbs by definition have no lexical relationship with prepositions, only syntactic ones formed *post hoc*. Therefore, there should at minimum be differences between the verb types and baseline verbs on the two dimensions that I have highlighted as of special importance: the predilection for dissociation and co-occurrence with particular prepositions.

The left hand plot compares the verb types against baseline for the dissociation rate (how often the verb and preposition were not immediately adjacent over the number of times the verb and preposition co-occurred), and the right hand plot gives the rate of preposition occurrence.

The plots show considerable differences between the verb types and baseline. Baseline preposition dissociation rate is very close to 1, while for exotransitives it is very nearly 0. Obligatory and alternating verbs occur in the middle ground, but even the median of the closest group (obligatory verbs, as it should be) is still close to 0.3 lower than baseline. Turning to the preposition occurrence rates, baseline is close to 0. Exotransitive is up at 0.75, while both alternating and obligatory have medians above the upper quartile of baseline and long tails. The conjunction of these properties if not each of them individually makes clear that these classes of verbs represent distinct relationships from baseline verbs.

2.4.2 Comparison of Verb Types on the Delineated Dimensions

Exotransitive verbs should have both low dissociation rates (and short dissociations) and high preposition occurrence, if they are distinct from the other classes. Alternating verbs should have low rates of dissociation like exotransitives, but also low preposition occurrence rates. Obligatory verbs should have preposition

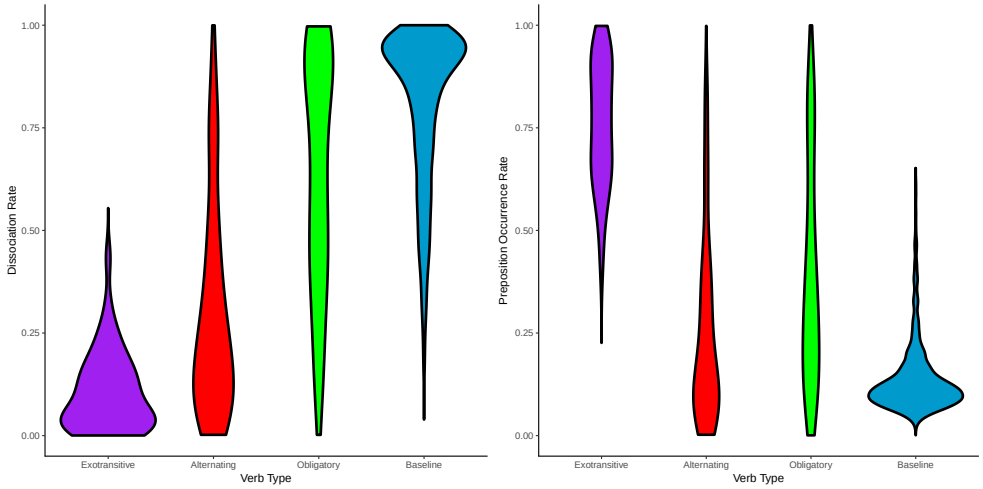


Figure 2.1: LEFT PANEL: Violin plot of the dissociation rate according to verb type. Despite the variation, an upward trend is discernible in accordance with expectations: exotransitives dissociate least, followed by alternating, obligatory, and finally baseline verbs. RIGHT PANEL: Violin plot of the preposition occurrence rate according to verb type. Exotransitives are very clearly greater in their occurrence rates than all other verb types, although more mass is concentrated in the upper parts of the range in the expected order: obligatory, then alternating and finally baseline.

occurrence rates closer to exotransitives, but higher dissociation rates. The scatterplot below gives the relevant comparisons along these dimensions.

For the most part, the different verb types appear to occupy different sections of the space. There is admittedly some overlap. Because verbs classified according to what is possible, rather than the way they typically occur, the two measures (preposition occurrence, dissociation rate) can sometimes be dramatically misaligned with the typical case. A significant contributing factor is that the macro-level distinctions of obligatory and alternating obscure syntactic microclasses. Consider the example of the verb *confess, admit, confide*, which are classed as obligatory verbs. These verbs are particularly complicated, since they actually have a mixture of properties with CP/NP alternating verbs in that they can both take an NP (20) and a CP (21).

(20) a. The burglar admitted his involvement to the detective.

b. The burglar confessed his crime to the priest.

c. The burglar confided his fears to the jury.

(21) a. The burglar admitted that he was involved.

b. The burglar confessed that he committed a crime.

c. The burglar confided that he was afraid of the death penalty.

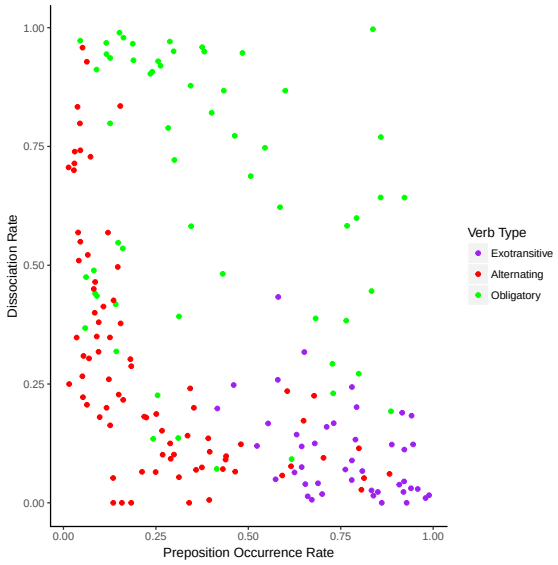


Figure 2.2: A scatterplot of the rate of preposition occurrence (x-axis) against the dissociation rate (y-axis). Exotransitive verbs are in purple, alternating in red, and obligatory in green. Exotransitives cluster largely in the bottom right. Alternating verbs remain close either axis. Obligatory verbs are the most variable, although they are generally high on the y-axis. There is, however, noticeable overlap.

Both the CP and the PP can occur together, and when they do, the heaviness of the CP leads to a production bias in favor of a PP-CP order, even though both are possible (22).

(22) a. The burglar admitted that he was involved to the detective.

b. ? The burglar admitted that he broke the latch on the door in order to force entry into the home to the detective.

c. The burglar admitted to the detective that he broke the latch on the door in order to force entry into the home.

Consequently, the dissociation rates are lower than expected. So, even though these verbs are logically obligatory verbs, they have some peculiarities that push them away from the mass of obligatory verbs. From inspection at a low level, there are several such classes which exhibit behavior that is modestly deviant from the bulk of cases in their class. Since they nonetheless meet the criteria, they are still included, but taking in to account syntactic peculiarities of particular classes aids in understanding some of the overlap between types.

On the whole, the findings are consistent with expectations. The exotransitives occupy the bottom right corner of high preposition occurrence and low dissociation rates. The bulk of the alternating verbs hang to the left of the plot, indicating low preposition occurrence but they also have generally lower dissociation

rates, as expected. Obligatory verbs are quite variable, but they have high dissociation rates and there are least some with preposition occurrence rates comparable to exotransitives. The variability of obligatory verbs is expected; it is well-known that arguments can be dropped for a variety of reasons, even though they are semantically present. The variability of obligatory verbs can be understood in those terms. Overall, however, the data depicted in the plot is consistent with the expectations I set out in the first section: exotransitives have very high (comparatively and objectively) preposition occurrence rates and very low (comparatively and objectively) dissociation rates.

2.4.3 Comparison of Verb Types according to the Association Measures

Though the plot above is suggestive, this finding needs a normalized measure of association to truly corroborate the expectations for the study. The boxplots below give an indication of how the different conditions differ in their mutual information content.

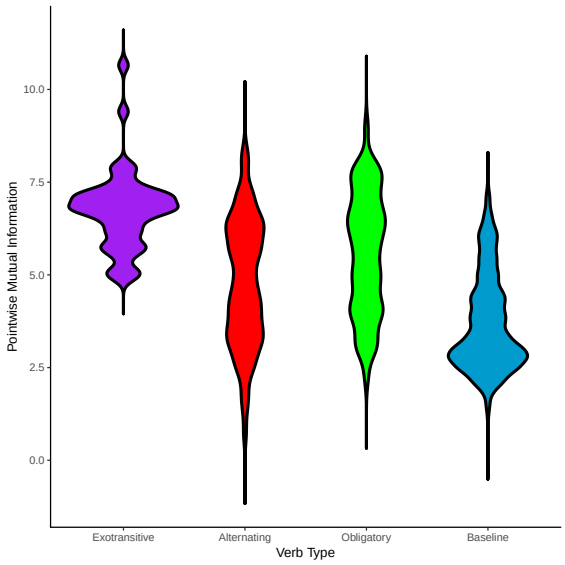


Figure 2.3: Violin plots of the pointwise mutual information according to verb type. The colors are the same as previous plots. The concentration of PMI is higher with exotransitive verbs than for other verb types, and it is higher with alternating and obligatory verbs than baseline verbs.

The pattern conforms to expectations: exotransitives have the highest mutual information content, and baseline verbs the lowest. Alternating verbs have the lowest of the verb types because they have a distinct syntactic frame which allows them to occur without the preposition. Obligatory verbs are short of exotransitives because their peripheral prepositional object can oftentimes be dropped in topic drop or they are given by context and may therefore be omitted.

A similar pattern is found with likelihood ratios. The boxplots below show a similar upward pattern to the association measure, with the baseline as the lowest and exotransitives as the highest.

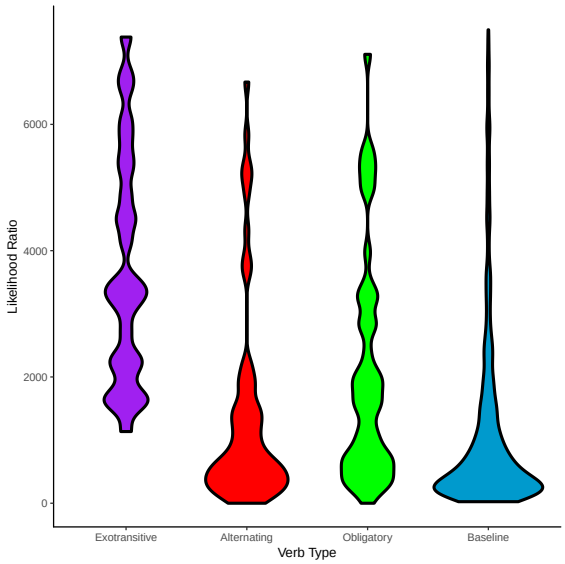


Figure 2.4: Violin plots of the likelihood ratio according to verb type. The colors are the same as previous plots. The concentration of likelihood ratio is higher with exotransitive verbs than for other verb types, and there are some higher concentrations with alternating and obligatory verbs than baseline verbs. Nevertheless, the spread is quite large.

Given the similarities between pointwise mutual information and likelihood ratios, it is clear that exotransitives are more associated than other verbs.

2.4.4 Quantifying Discriminability of Verb Types

Verb types have been compared on four measures, two of the classificatory (preposition occurrence, dissociation rate), two of them measures of association (pointwise mutual information, likelihood ratio). Qualitatively, exotransitives appear quite clearly to be a class of verbs distinct from obligatory, alternating and baseline verbs. There is nevertheless significant overlap, which is particularly clear from Figure 2.

As it stands from qualitative inspection alone, it could be that exotransitives are just particularly strong case of e.g obligatory verbs without an internal argument, or PP/$\emptyset$ alternating verbs with very infrequent null exponence. But it is important for the following argument that exotransitives be distinct - and thus deserving of a unique analysis - rather than just the extreme of a continuum of verb-preposition associations.

To that end, Tables 1 and 2 present quantitative measures of discriminability. Two measures are used: the p-value of χ^2 tests on the binned distributions, and the Jensen-Shannon divergence (JSD). χ^2 tests

Table 2.1: χ^2 Tests

Comparison	Prep. Occurrence	Dissociation Rate	Mutual Information	Likelihood Ratio
Exotransitive:Obligatory	$< .0001$	$< .0001$	.0034	0.0358
Exotransitive:Alternating	$< .0001$	.0005	$< .0001$	$< .0001$
Exotransitive:Baseline	$< .0001$	$< .0001$	$< .0001$	$< .0001$
Obligatory:Alternating	.0652	$< .0001$	.1087	.1240
Obligatory:Baseline	$< .0001$	$< .0001$	$< .0001$	$< .0001$
Alternating:Baseline	$< .0001$	$< .0001$	$< .0001$	$< .0001$

Table 2.2: Jensen-Shannon Divergence

Comparison	Prep. Occurrence	Dissociation Rate	Mutual Information	Likelihood Ratio
Exotransitive:Obligatory	.7285	.8760	.9218	.7459
Exotransitive:Alternating	.8890	.4278	.9343	.8010
Exotransitive:Baseline	.7184	.8062	.9413	1.000
Obligatory:Alternating	.4735	.7423	.8646	.8294
Obligatory:Baseline	.4361	.5295	.8983	.8813
Alternating:Baseline	.5254	.6568	.8443	.9509

confirm that the distributions are indeed different from each other (despite their overlap). The JSD gives a measure of how separate the distributions are from each other, ranging from 0 to 1, where 1 is complete divergence, and they are the same when it is 0. Pairwise comparisons are made for all classes of verbs.

The tests find significant differences between exotransitives and every other class of verb for each measure. Indeed, they discriminate between baseline verbs and each of the verb types where prepositions and verbs are associated (exotransitive, alternating, obligatory). Obligatory and alternating verbs are not clearly distinguished by these tests, however. Only on what was argued to be the main distinctive feature, dissociation rate, do the tests find a significant difference. These results are reflected also in the JSD metrics, shown in Table 2.

As before, the JSDs show that exotransitives are highly discriminable on the relevant dimensions. They are near the limit of 1 except on the dimension of dissociation rate in their comparison with alternating verbs, which is unsurprising given what has been demonstrated about their properties.

2.5 Discussion

All of the criteria that were laid out for distinguishing exotransitives from alternating and obligatory verbs are verified by the study: exotransitives have higher preposition occurrence and lower dissociation rates. They differ on the expected dimensions from alternating and obligatory verbs, which are themselves distinct from verbs at large. Quantitative support was offered by χ^2 tests and the Jensen-Shannon divergence.

The similarity of exotransitives to transitives is the primary concern of the studies that constitute the

remainder of this dissertation. To that end, I have demonstrated that exotransitives are distinct from other verb-preposition constructions. In having both low dissociation rates and high preposition occurrence rates, they are much like simple transitives in the way that they relate to their objects[2]: they dissociate only infrequently, and they have high rates of occurrence. What is principally different between exotransitives and transitives is that, for reasons as yet unexplained, exotransitives express their internal arguments with prepositions. This will be addressed in later chapters. For now, however, there is more to say about the way exotransitives (and the other verb types) relate to prepositions.

2.6 Extending the Findings

The findings thus far support the classification of exotransitives as transitive verbs. But there are several properties of exotransitives that, when investigated, provide further insight into their nature. Two of those properties will be investigated here: transitivity and argument occurrence.

2.6.1 Nominal Exotransitives and Transitivity

Transitivity is classically a property ascribed to verbs that take an internal argument. One reason to think that transitivity is a property of *verbs*, or at least of non-nouns, is that deverbal nouns do not take their corresponding verbal objects, or denominal verbs take objects that they did not take as a noun. Some examples of this are shown by the pairs below.

(23) a. Martha demanded payment for her work.

b. Martha made a demand *(of) payment for her work.

c. The doctor extracted the parasite from her patient.

d. There was an extraction *(of) the parasite from the doctor's patient.

As is well-known, the noun of a given derivationally related verb-noun pair requires the preposition *of* to take its erstwhile object. Exotransitives are a uniquely interesting case, then, because of the potential competition with the basic preposition *of* and a preposition that they are related to in the verbal domain.

The comparison of *of* with exotransitively-associated lexical prepositions sets up an interesting contrast which concerns whether the association of prepositions is a property of the meaning of the preposition and the verb together, or whether it is some property of the syntax of verbs and prepositions themselves. If

[2]Assuming, as is indeed the case, that their prepositions require direct objects.

exotransitives are like transitive verbs, then they would be expected to occur with *of* like other transitives when they are verbalized. On the one hand, it is possible that the association of the preposition with the verb comes about syntactically, perhaps through subcategorization, and a new, generic association with *of* is built in the syntax when the verb is a noun. Work in generative syntax supports the idea that nouns do not take arguments (Kayne 2009, Donati & Cecchetto 2011), and so the subcategorization frame responsible for determining the presence of the preposition is not part of the lexical entry of a deverbalized exotransitive, thus the presence of *of* rather than a lexical preposition.

On the other hand, if the meaning component common to the nominal and verbal forms of an exotransitive is responsible for the appearance of the preposition, the occurrence of the lexical preposition should both exceed the occurrence of *of* and should occur relatively often. Instead of the syntax being responsible for building associations between verbs and their prepositions, some part of the idiosyncratic meaning of the verb demands the co-occurrence of some particular preposition.

To investigate this, morphologically related nouns of all three subtypes of verb and were examined, looking particularly for their occurrences with *of* and the most frequent associated lexical preposition. These are given in Appendix B. Primarily, these were derived with the *-(t)ion* suffix (*gravitate/gravitation*) or with the *-ence* suffix (*depend/dependence*; *reside/residence*), but there were also a significant number of conversions ($stare_v/stare_n$). The rates of occurrence of the two prepositions with the verb were compared. The plot below depicts this, with the rates of occurrence of both prepositions over the total number of occurrences of the noun.

The plot shows an interesting finding: the verbs, regardless of type, tend to occur with just one or the other preposition, or else only infrequently occur with any preposition at all. The absence of points in the middle portion of the plot shows that there are no "alternating" nouns in the way that there are alternating verbs: no nouns reliably alternate between *of* and their lexical preposition. More importantly, the plot appears to show that, for the nouns that frequently associate with prepositions, they split into either a "syntactic" association group (high *of*), or a meaning association camp (high lexical). However, while the plot is very illuminating, it does obscure important information. Since it depicts the rates of occurrence for both types of preposition absolutely, it is difficult to extract information regarding how the rates of occurrence differ by noun type. At least with the particular nouns in question - if not more broadly - the occurrence of PPs is infrequent, headed by *of* or otherwise. Consequently, the rates themselves are not totally informative about the association strength of a particular noun with *of* versus a lexical preposition. That information is given easily by taking the difference between the occurrence of the lexical preposition and the occurrence of *of*,

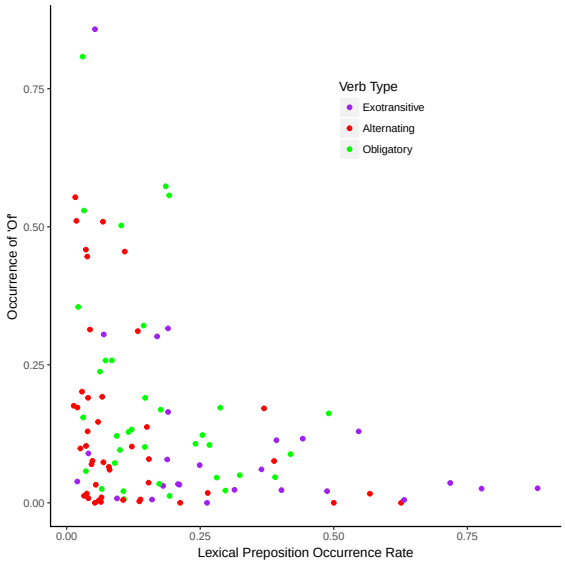


Figure 2.5: Scatterplot of the occurrence of the lexical preposition with nominal forms of exotransitive, alternating, or obligatory verbs against occurrence of pleonastic *of*. The indicated occurrence rates are raw rates of the indicated preposition's occurrence, so values must be less than 1 but need not sum to 1. Exotransitive verbs generally like along the x-axis of lexical occurrence rates. On the other hand, obligatory and alternating verbs spread out along either axis.

Table 2.3: Discriminability of Lexical Preposition Occurrence Rate

Comparison	χ^2	JSD
Exotransitive:Obligatory	.256	.8430
Exotransitive:Alternating	.054	.8740
Obligatory:Alternating	.542	.644

which is shown by the density plot below.

The figure shows an interesting pattern. While both obligatory and alternating verbs have their mass very close to 0 (little difference in relative occurrence rates), exotransitives have most of their mass above 0. That observation confirms that exotransitives occur far more often with their lexical prepositions than the other types of verb. The more important implication of the plot is that the rate of occurrence of the lexical prepositions between nominal exotransitives and verbal exotransitives is quite different: verbs are far more likely to have their lexical prepositions (on average, 70%) than nouns (on average, 30%). Quantitative results back up the discriminability of the distributions.

Even though the χ^2 tests never reach significance, the JSD numbers indicate high disciminability of the exotransitives from the obligatory and alternating classes. Obligatory and alternating verbs on the other hand are considerably less disciminable.

This difference between exotransitives on the one hand and obligatory and alternating verbs on the other

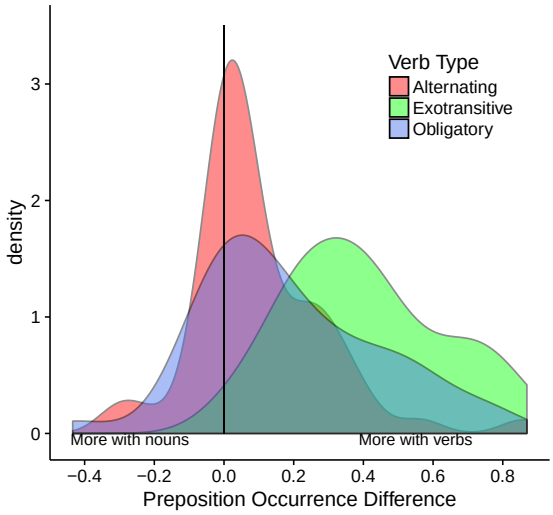


Figure 2.6: Density plots of the difference between occurrence of the lexical preposition with verbal forms and nominal forms. The black vertical line stands at 0. Values to the right of that line indicate greater occurrence with verbs, values to the left indicate greater occurrence with nouns. The modes of the distributions of obligatory and alternating verbs are at 0. On the other hand, the mode of the exotransitive distribution is firmly in the verbal area, indicating that the preposition has a greater affinity with verbal exotransitives than nominal(ized) forms.

speaks to the fundamental dependence between exotransitive verbs and their prepositions in particular, which does not carry over into the nominal domain. By contrast, this is not true of alternating and obligatory verbs by-and-large, since with a few exceptions there is no appreciable difference in occurrence rates between nominal and verbal forms.

2.6.2 Meaning and Argument Occurrence

Is it a property of the occurrence of *arguments* with such verbs that is driving the high preposition occurrence rate, or is it a property of the verb itself? Put another way, certain verbs like *dress* are equally well-formed with or without a complement (*The caretaker dressed the baby* versus *The caretaker dressed*). The flexibility of the meaning of *dress* plays a role in this; one may either dress oneself (no object), or dress another (object) because an event of dressing might only affect the subject, or it might be specified to affect another. But a verb like *hit* is rarely well-formed without a complement, because an event of hitting necessarily affects something else.

It is conceivable that the class of exotransitives have meanings more like *hit* in this respect than *dress*. Were this so, the high occurrence of the preposition is a property of the meaning of the verb, and ultimately this cause is identical to what drives the high rate of object occurrence for *hit*. There are other possibilities, however. The high rate could be due to the verb being *semantically dependent* on the preposition. This

differs from the previous option in a subtle but important way. Instead of taking a complement by virtue of a semantic representation that is ill-formed without a nominal object, the exotransitive must take a preposition by virtue of a semantic representation that is ill-formed without a properly marked nominal object. On the latter view, the preposition is performing a critical function of marking the nominal object for some semantic purpose (as a specific thematic or semantic role), and so the verb cannot occur without it.

The question of which of these views is correct can be addressed with a simple comparison. By comparing the occurrence of complements between exotransitives and close simple transitive synonyms, it is possible to infer whether it is some property of the meaning which is driving the high preposition occurrence. Each candidate verb was paired with its closest acceptable object-taking synonym. These can be found in Appendix C. The corpus was searched for the occurrence of NPs after the synonyms and compared with the rate of preposition occurrence with the candidate verb. The difference between the two rates reflects relatively the strength of association of the two types of complements for the common meaning.

A difference of 0 means that the common meaning is equally likely to occur with a PP or an NP. Rates below 0 reflect a preference for the NP complement, and rates above 0 represent a preference for the PP complement. How these rates differ by preposition type is given below.

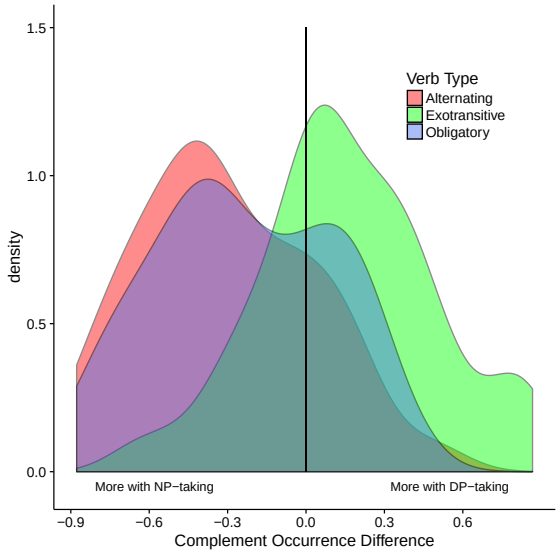


Figure 2.7: Density plots of the difference between occurrence of the complements with verbs and their close synonyms. The black vertical line stands at 0. Values to the right of that line indicate greater complement occurrence with the verb that takes a PP (exotransitive/alternating/obligatory), values to the left indicate greater occurrence with their synonyms. The modes of the distributions of obligatory and alternating verbs are to the left. On the other hand, the mode of the exotransitive distribution is slightly to the right of 0, indicating that the preposition about as much affinity with their complements as their transitive synonyms.

There is considerable variation within the preposition types, but some differences are clear and interesting.

Table 2.4: Discriminability of Complement Occurrence Rate

Comparison	χ^2	JSD
Exotransitive:Obligatory	.0012	.790
Exotransitive:Alternating	.0002	.759
Obligatory:Alternating	.2908	.692

Most importantly, while the trend is slight, about twice as many exotransitives are well above 0 (> 0.2) then well below (< -0.2), and the majority are above 0. The differences between verb types is confirmed by quantitative measures.

Exotransitives are significantly different from obligatory and alternating verbs, with high discriminability, on argument occurrence with their synonyms. This suggests that the results are more consistent with a semantic association between exotransitives and their prepositions driving the high occurrence. The second observation from the plot is the stark contrast between exotransitives and the alternating and obligatory verbs. Both of these verb types occur with their prepositional complements far less often than their closest synonyms occur with their nominal complements. The manner of association between the preposition and alternating and obligatory verbs is therefore different from exotransitives. That conclusion is consistent with the findings of differences in the association measures and the dimensions of interest.

2.7 General Discussion

The motivation for this study was first to establish the existence of exotransitive verbs as a distinct class of English verbs. This was conclusively shown with a corpus study of the BNC. In contrast to alternating verbs, obligatory verbs, exotransitives have higher rates of preposition occurrence and low rates of dissociation. They also score better on association measures than any other class, which demonstrates that they are *bona fide* collocations.

The second major concern of this study was to demonstrate that not only are exotransitive verbs a distinct class, but they are like simple transitive verbs generally. This was supported by the high rate of occurrence of the (obligatorily object-taking) PP complement and the low rate of dissociation (two hallmarks of transitives). The case was strengthened with two follow up comparisons that supported some of the properties already ascribed to exotransitives.

The first follow-up demonstrated a key premise of the second follow-up, namely that exotransitives associate with their verbs for semantic reasons, although they have lower rates of preposition occurrence as nouns (like simple transitive deverbals). The second follow-up compared the rates of argument occurrence

between exotransitives and simple transitive synonyms. In general, they have similar rates of argument occurrence, although exotransitives do have slightly higher rates. In sum, then, exotransitives occur with their complements about as often as simple transitive verbs, and dissociate from their PPs only rarely. They resemble simple transitive verbs in all relevant respects, and so they should be treated as such.

2.8 Rejecting Other Assimilatory Approaches

The conclusion that exotransitives are like simple transitives is central to the studies that follow. In order to move forward with an analysis that treats exotransitives as a distinct class of transitive verbs, I have to discuss and dismiss the remaining assimilatory approaches. These approaches, namely that exotransitives are idiomatic, they are unique selectional phenomena, or they are compounds, may be *prima facie* consistent with the results of the corpus study. Importantly, they are also associated with known mechanisms which do not make exotransitives out to be transitives in any genuine sense. I move on to discussing these now.

2.8.1 Idioms

It is clear from the outset that exotransitives and idioms share certain similarities. Exotransitives, like idioms, are fixed expressions composed of multiple words, and they may be compositionally opaque. In other words, exotransitives and idioms both are composed of distinct lexical items that combine to be interpreted as a whole. For idioms, the resultant interpretation is not necessarily composition. For example, *to kick the bucket* used idiomatically does not refer to the kicking of an actual bucket. Yet, each of the words in *to kick the bucket* is necessary to get the idiomatic interpretation.

For exotransitives, it is not entirely clear if the resultant interpretation is compositional. Some exotransitives like *gravitate to* seem transparently compositional, while others like *dispose of* are opaque at best. Even so, certain authors like Nunberg, Sag and Wasow (1994) have argued that idioms also may vary in how compositional they seem. For example, there appears to be a combinatorial component to an idiom like *pop the question*, with *the question* being the object of *pop*. If idioms are not *definitionally* associated with non-compositionality, then exotransitives and idioms cannot be distinguished by the transparency/opaqueness of the relationship between their constituent parts. Thus, the singular compelling similarity between exotransitives and idioms is that they are fixed expressions. The defining property of idioms, however, is not that they are fixed expressions, but that they have two interpretations: a literal interpretation and a figurative one. So (24) can mean either that *Bernard* kicked an actual physical bucket (literal), or that he died (figurative)

(25).

(24) Bernard kicked the bucket and it flipped over.

(25) Bernard kicked the bucket and his wake will be on Friday.

Whether exotransitives can be considered idioms depends on whether they have both a literal and a figurative meaning. At first this does not seem implausible; many exotransitive verbs have an opaque relationship with their preposition, where the preposition does not appear to be being used in any of its identifiable senses. Some examples are *concentrate on, abstain from*, and *revel in*, where the predominantly locative prepositions *on, from, in* have no clear locative interpretation. Furthermore, many exotransitives have simple verbal synonyms, in the same way that idioms do. For example, *masquerade as* and *impersonate* in (26-27) are tantalizingly similar in their relationship to (24-25).

(26) The mailman masqueraded as their next door neighbor.

(27) The mailman impersonated their next door neighbor.

Nevertheless, it is apparent that exotransitives do not have the literal/figurative pairing of meanings. There is only one interpretation of *masquerade as* in (26). It is also worth noting that not all prepositions in exotransitives have an opaque relationship to their wider uses. *Reside in* and *gravitate to*, for example, make use of obviously locative meanings of their prepositions.

Perhaps the biggest strike against an idiomatic analysis is that even in their figurative uses, exotransitives exhibit class-like groupings. Below are some examples.

Prep	Class	Shared Meaning
on	count, depend, rely, hinge	putting trust for some outcome
	ruminate, cogitate, concentrate	thinking with acute focus
	encroach, trespass, intrude, infringe	entry in impermissible area
to	cater, pander	attentiveness with intent to ingratiate oneself
	assent, accede, acquiesce, capitulate	agreement
	resort, revert, regress, degenerate	movement backgrounds to a previous state
with	dovetail, correspond, correlate, resonate	harmonious complementarity
	commune, consort, hobnob	meeting
	interfere, meddle	exert influence on something without permission
in	bask, revel, glory, luxuriate	celebrate
	delve, barge	enter headlong
	dwell, reside	live
from	abstain, refrain	not partake in
	emanate, stem	come out from
	divest, detract	remove something of value

Idioms do not group into classes based on the relationships of their constituent parts. In other words, the meanings of *fit as a fiddle*, *play second fiddle*, *(be) played like a fiddle* and *on the fiddle* have no particular relationship to one another by virtue of all containing *fiddle*. They have no common meaning, much less one that is even partially related to fiddles. This is quite unlike the verbs *count on, depend on, rely on, hinge on*, which share some meaning component and also all occur with *on*. In other words, exotransitives group into classes according to some shared meaning of the verbs. This shared meaning brings along with it some association with a particular preposition. Contrast the relationship of form to meaning found in exotransitives with that found in idioms.

Meaning	Idioms
to die	kick the bucket, buy the farm, meet the maker, cash in one's chips
to give up a secret	let the cat out of the bag, give the game away, spill the beans
to face consequences	fall on one's sword, face the music, chickens coming home to roost

As can be seen, many idioms concern the same topics, but they do not have the same form-meaning correspondence that exotransitives do. Consequently, the fact that the preposition and the exotransitive group

together according to their meanings renders an idiomatic analysis impossible. Add this to the fact that exotransitives do not have dual literal/figurative meaning pairs, and it is clear that they cannot be analyzed as idioms.

2.8.2 Selection

As I will discuss in the next chapter, some attempt has been made to capture exotransitives with the mechanics of selection. Pesetsky (1996), for example, proposed that a subcategorization frame should be permitted to select for particular lexical items, a mechanism which he called l-selection. It is fair to say , though, that the idea of capturing exotransitives with selectional phenomena is a broader one than just Pesetsky's l-selection. The function of selection is the determination of certain properties of a complement, and the exotransitive always associates with the preposition. It stands to reason then that the verb is selecting for the preposition.

However, the relationship that exotransitives have with broader selectional phenomena does not support their categorization as selectional. On the surface it does appear that exotransitives are simply associating with their prepositions by selection, but deeper exploration reveals that it is not so. I will draw on facts from both c- and s-selection to make a case that exotransitives are not produced by selection.

Consider c-selection first. C-selection is the mechanism by which heads determine the category of their complement. C-selectional requirements typically define subcategorization frames, and also include information about the optionality of certain arguments. The examples below demonstrate the categorial selection as well as optionality information.

(28) a. kick [NP ___ NP]

b. eat [NP ___ (NP)]

Subcategorization also addresses variation in the syntactic category of a complement to ensure that a head takes at least one of its possible complements. *Believe*, for instance, can take a PP, NP, or CP complement.

(29) a. The crowd believed the prophet. (NP complement)

b. The crowd believed in the prophet. (PP complement)

c. The crowd believed that the prophet was telling the truth. (CP complement)

Because *believe* is variable in the type of complement it can take, its formalization must be a little more sophisticated than (28). To ensure that it takes one and only one at a time of NP, PP, or CP, *believe*'s frame

would be formalized like (30).

(30) believe [NP ___ $\left\{ \begin{array}{c} \text{NP} \\ \text{PP} \\ \text{CP} \end{array} \right\}$]

Consider the subcategorization frame of a preposition like *on*. The formulation in (31) is sufficient to capture prepositional *on* in seemingly every context, including exotransitives. Examples from several distinct contexts show that (31) is sufficient for all of them.

(31) on [___ NP]

(32) a. Carly put the notes on the desk. (Locative PP argument)

b. This urban legend occurred on a hot summer evening. (Adverbial PP)

c. The patient in room four is on a morphine drip. (Predicative PP)

d. Everyone was reading the books on critical theory. (Argument of an NP)

e. An elderly couple read the newspaper on a bench. (PP Adjunct)

f. Moses relied on the arrival of more supplies. (PP complement)

It should come as a surprise, then, that combining *on* with an exotransitive like *depend* opens up c-selectional possibilities (33) that are otherwise impossible (34).

(33) a. The arrival of the supplies depended on if the locomotive had been repaired.

b. Whether the locomotive had been fixed depended on if the repair crew had not taken a nap.

(34) a. * This urban legend might have occurred on if the summer evening was hot.

b. * Everyone was reading the books on if critical theory was right.

c. * The patient in room four is on if the nurses attached the morphine drip.

(33) shows examples of *on* taking a clausal complement, which it otherwise cannot do (34). This is not a property that either *depend* or *on* possess on their own. If *depend* itself subcategorizes for anything, it subcategorizes at most for a PP headed by *on*, and *on* is incapable of taking a CP headed by *if* outside of the limited contexts provided by some exotransitive verbs. Other verbs which show this kind of unique selectional behavior use a variety of prepositions, like *stem from, account for, object to*.

The fact that the combination of verb and preposition in exotransitives opens up new selectional possibilities that neither could achieve on their own is mysterious, since selectional properties are idiosyncratically

associated with lexical items. The only way for a preposition like *on* to be able to subcategorize for a CP is if it had a separate lexical entry (on_2) with that ability only. But that would necessarily ignore that on_2 only ever occurs with exotransitive verbs. It would also complicate exotransitive verbs like *depend* because they would have to now subcategorize for both on_1 and on_2. Aside from the sudden ability to select both a CP or an NP, there seems to be no reason to posit an item like on_2. The result is a more complicated picture which restates rather than explains the data. These undesirable consequences can be avoided by saying that *depend* and *on* are combined into a separate lexical item capable of taking either a CP or an NP.

(35) depend [on ___ $\left\{ \begin{array}{c} \text{NP} \\ \text{CP} \end{array} \right\}$]

A similar conclusion can be reached by investigating the s-selectional properties of exotransitives. S-selection describes the requirement of a selecting head for a complement with certain semantic properties. It was introduced in Grimshaw (1979) to account for differences in the propositional content of clausal complements, and it operates strictly on the selection of complements according to the semantic features. Formally, this is accomplished by specifying semantic properties in the subcategorization frame. One could, for example, reduce the complexity of the subcategorization frame of *believe* by stating that its complement must be either animate or a proposition, since each of the complement types can do either of these.

(36) believe [___ $\left\{ \begin{array}{c} [\ +\text{animate}\ ] \\ [\ +\text{prop}\ ] \end{array} \right\}$]

As with c-selection, the head specifies certain properties of its complement, and these properties are associated with the lexical item itself. The only difference between s-selection and c-selection is the kind of features it concerns.

Again, exotransitive verbs provide some surprising data for s-selection. The preposition *upon* does not select for any particular semantic properties of its complement NP. (38) shows examples of locative *upon* occurring with concrete nouns of varying animacy and plurality, and also examples with abstract nouns.

(37) upon [___ NP]

(38) a. Carly put the notes upon the bench/rocks/dog.

b. Mary layered criticism upon the concept of heroism/John's already damaged confidence.

Consider the behavior of *upon* in one of its exotransitive collocates, *prey*. As in the case of *depend*, the exotransitive *prey* cannot be said to have any selectional properties of its own except, by hypothesis, *upon*

(or *on*). And yet, together, they can only occur with animate nouns (in particular, things that can be food)[3].

(39) The newfound mammal preys upon plants/animals/*rocks/*emotions of all kinds.

There are many exotransitive verbs like *prey* that have semantic restrictions on the object of the preposition; *recuperate from* only concerns an infirmity, *preside over* only concerns some state of affairs which makes use of an adjudicator, and *regress to* only concerns scalar states. Where does these restriction come from? Not evidently either the verb or the preposition. Indeed, according to Grimshaw (1979), s-selection is strictly local, in which case the verb could not be doing the selecting, and the preposition does not by itself possess a restriction only for animates as shown by (38). This is the same problem as before: the preposition cannot be doing the selecting because it does not enforce those selectional restrictions elsewhere.

Nevertheless, one might imagine that s-selection is not strictly local, and that the verb possesses the selectional properties itself and can also select "through" the preposition. While this is initially appealing, it falls apart quickly. Were this option true, then verbs that have certain s-selectional requirements should enforce them similarly on both an NP complement or the NP complement of a complement PP. Alternating verbs, like *indulge (in), issue (from)*, which must take either an NP complement or a PP headed by a particular preposition (but not both simultaneously) are test cases for this. If verbs s-select through complement prepositions, then the same s-selectional requirements should be enforced on NP complements as on NP complements of PP complements. This is false (40-41).

(40) a. indulge [___ $\left\{ \begin{array}{c} \text{NP}_{[+\text{desire}]} \\ \text{NP}_{[+\text{human}]} \\ \text{in NP}_{[+\text{object-of-desire}]} \end{array} \right\}$]

b. Maria indulged her hunger/her friend/*the rich dark chocolate.

c. Maria indulged in the rich dark chocolate/*her hunger/*her friend.

(41) a. issue [___ $\left\{ \begin{array}{c} \text{NP}_{[+\text{concrete}]} \\ \text{NP}_{[+\text{human}]} \\ \text{from NP}_{[+\text{source-location}]} \end{array} \right\}$]

b. The army issued the soldiers with the gear/*their trenches.

c. The army issued gear/*their trenches to the soldiers.

d. The army issued from their trenches/*gear/*the soldiers.

Therefore, it can be concluded that exotransitives are not a form of selectional phenomena.

[3]Any other occurrence is arrived at through semantic coercion.

2.8.3 Compounds

A final possibility is that exotransitives are compound verbs. The simplest description of compounds is that they are a word which is composed of more than one word. Because compounds behave syntactically and morphologically like a single word, otherwise independent-looking words can behave like verbs (42) (Lieber 1992; Jackendoff 2009). In this sense, they are not dissimilar from exotransitives (43).

(42) a. The workers *hand dried* the dishes.

b. They had to *forcefeed* the baby chicks.

c. The interviewer stopped *browbeating* the interviewee.

(43) a. The prince wouldn't stop *meddling with* the toy cannon.

b. We weren't sure if the action *impinged upon* the agreement.

c. By the end of the hearing, the defendant was *divested of* several million in assets.

There are some characteristics of compounds that are attractive as an analysis of exotransitive verbs. Firstly, they are can intuitively capture the sense in which exotransitives are like a single word although they are composed of two identifiable words. Like exotransitives, the actual meaning of compounds can be quite unpredictable from the combination of the parts. So, a compound like *redhead* describes a person with red hair, even though no part of the compound gives an indication that the referent is human. Similarly, it is not clear what the contribution of *with* is in an exotransitive like *meddle with.* Finally, exotransitives also bear similarities to words that really do appear to be compounds, at least on the surface. English is replete with particle+motion verb combinations like *downfall, overthrow,* and *upturn.*

Nevertheless, the compound analysis falls apart quickly. English compounds are right headed (Lieber 1992), and so it is the rightmost element which should receive inflectional morphology in a compound. As can be seen from (43), it is the verb - the leftmost element - and not the preposition which receives the verbal morphology in exotransitives. Another reason to discard a compound analysis is that compounds are by nature inseparable (Jackendoff 2009). The constituent words are concatenated to form the compound, and remain that way in order for them to be interpreted as a compound. But one of the foundational facts about exotransitives established in Chapter 1 was that they were in principle separable. (44) from Chapter 1 is reproduced here.

(44) a. To the cookies Clancy gravitated.

b. Afterward the guests will partake for about an hour of our world famous cider

c. It is on public transportation that Steve relies.

It can be concluded on the basis of the placement of inflectional morphology and the separability of the verb and preposition that exotransitives are not compounds.

2.9 Summary

To conclude this section: an analysis of exotransitives either as idioms or selection fails to capture the range of facts. Exotransitives do not exhibit a dual literal/figurative meaning pairing that defines idioms, and they do exhibit unique selectional properties when combined. They are also separable, as shown in Chapter 1, which rules out a compound analysis. The take away from this is that the commonalities between exotransitive verbs and transitive verbs must be taken seriously. There are no easy assimilatory explanations. As I will argue beginning in the following chapter, a synthetic approach should be taken.

CHAPTER 3

The Nature of Prepositions

3.1 Approaching Exotransitives Synthetically

Two facts are evident from Chapter 2. First, exotransitives are a real class of verbs which have in common the expression of the internal argument by means of a preposition. Second, the occurrence (and function) of the preposition cannot be assimilated to existing phenomena. In Chapter 1, I claimed that there were two possible approaches to exotransitives: an assimilation approach, and a synthetic approach. The former I have already dismissed. I take up the latter here.

On a synthetic approach, exotransitives and simple transitives are both possible manifestations of the same underlying common transitive representation. I will ignore for now what form that representation takes (i.e, whether it is in the lexicon, the syntax, or the semantics), but I will come back to it later. What matters for now is that a synthetic approach is the more appropriate. Exotransitives and simple transitive both take an obligatory internal argument which does not readily tolerate separation. This similarity is more significant than the occurrence of the preposition. Two things are needed to make a synthetic approach work: first, an analysis of transitivity that unifies exotransitives and simple transitives, and second, some explanation for the occurrence of prepositions with exotransitives.

To meet these challenges, a better understanding of prepositions is needed. Prepositions are the key to both the main similarity (the licensing of an obligatory internal argument) and the main difference (the preposition). In order to understand exotransitive verbs, the focus for now should be on prepositions. A proper survey will address their own categorical status, and also how they relate to verbs in argument structure generally. Both topics are relevant to exotransitives. What the categorical status of prepositions is provides the groundwork for the angle that exotransitives should be viewed from. If they are nominal at some significant level, as some authors suggest, then theories and mechanisms which relate extended nominals to verbs should be considered. Immediately a speculative solution comes to mind if this is true. If PP is an extension of the extended nominal domain, and as such arguments can be marked through it in the same way that arguments can be marked through NPs or APs. On the other hand, if they are by nature

verbal, as suggested by other authors, then analogies to causatives or serial verb constructions are in order. Similarly, argument structure is highly relevant, since the relevance of argument structure and mapping to exotransitives (where the internal argument is taken by a preposition) is unquestionable.

Prepositions thus need to be set against the proper background of these two main topics. In what follows, I will first survey the literature on the nature of prepositions generally, and then specifically how they are treated within a broader conception of syntactic categories. I will pay particular attention to what other categories they are identified with, what their purported function is, and whether they are given content within such a theory. I will keep myself only to work which makes a detailed effort at understanding prepositions. Within the body of literature on this question, there are two main camps.[1] One identifies prepositions with nominals, and the other with verbs. I will discuss these in detail.

The second topic that I will concern myself with is the treatment of prepositions within theories of argument structure. This work augments the theories that concern prepositional category with theories of how prepositions link nominals and verbs. Together, analyses of prepositions within theories of syntactic categories and argument structure fully answer the questions I lay out in the introduction, as will be seen. Nevertheless, by themselves, the category literature and the argument structure literature leave gaps in our understanding of prepositions. I will therefore set them down side by side in this review.

Following on this, I will discuss the topic of exotransitive verbs, such as it is. The literature is sparse and largely silent on the topic, and no accounts dedicated explicitly to them exist. Nevertheless, I will recount the works that give them attention so that when I discuss their theoretical importance, the theoretic background will be familiar.

3.2 The Starting Point

The starting point for the investigation of prepositions is Jackendoff (1977). Previous commentators like Chomsky (1970) had remarked on prepositions but not in detail or with interest. Jackendoff, on the other hand, ascribes more importance to prepositions. It is not uncommon even today to find Jackendoff's analysis as the starting assumption about the organization of major syntactic categories. Mark Baker, in his 2003 book *Lexical Categories*, writes of this view:

> For many years, most of what the Principles and Parameters tradition of Generative Syntax has

[1] I will leave aside one-off analyses or positions rarely argued for, such as Baker (2003)'s position that prepositions are like adjectives. I will also, perhaps somewhat controversially, exclude the idea that PPs are a type of CP from this review since such a view is effectively irrelevant to the forthcoming work, but the reader is referred to Geoffrey Pullum's work for some discussion of this.

> had to say about the lexical categories is that they are distinguished by having different values for the two binary distinctive features +/-N and +/-V...the gap was filled in by Jackendoff (1977), in his influential view [of syntactic categories].

Because of the pervasive influence of this view, and the sway it yet holds on the topic of syntactic categories, it is treated here independently of the other traditions which I later recount. His proposal is simple. He takes Chomsky (1973)'s categorical features ("major class" features, identified only weakly with semantic content) [±V, ±N] and rearranges them into a matrix which identifies each of the major categories.

$$\begin{array}{c} \\ +\mathrm{N} \\ -\mathrm{N} \end{array} \begin{array}{c} \begin{array}{cc} +\mathrm{V} & -\mathrm{V} \end{array} \\ \begin{bmatrix} \mathrm{A} & \mathrm{N} \\ \mathrm{V} & \mathrm{P} \end{bmatrix} \end{array}$$

Unlike Chomsky, Jackendoff's proposal includes prepositions among those that are defined by [±V, ±N]. With the same move, he identifies them with the content of other classes. Prepositions are [-V] like nouns, and [-N] like verbs.[2]

The reason Jackendoff elevates prepositions to a major category is because he is impressed with certain facts about their distribution and structural properties. For example, he finds the commonality between verbs and prepositions in taking objects to be compelling. Though he ultimately seeks an explanation in terms of a feature that is in essence defined by this property, the fact that both categories take arguments is highly significant. Jackendoff also argues that V and P are similar because of a number processes that operate on V and P alone.[3] He specifically cites the distribution of gerundives and PPs, the ability to assign case to their complement, and their ability to select different kinds of complements (NP, S) all make the two categories similar. The relative scarcity of operations that operate on N and P seals the matter for Jackendoff. Even though categories V and P can be characterized as [-N], he can name only one transformation (clefting) that targets just [-N] categories. Thus, the fact that operations in the syntax frequently affect V or P (or V and P) but rarely group P with other categories suggests to Jackendoff that P and V share some critical properties. He does not go farther about identifying what those properties specifically are, since they are contained within the featural identifications he has made.

[2]Jackendoff revises the meanings of the features substantially as well, such that their properties are to be identified with structural correlates ([+Subj] items have a subject, [+Obj] items take an object, etc.), though this proposal has garnered significantly less attention.

[3]Which is much higher in the theoretical framework in which he was writing than in contemporary minimalist syntax.

For most authors, Jackendoff's system remains the basic assumption about the organization of major categories, and thus the role of prepositions within the syntax and the grammar at large. The only comparable tradition is one that Jackendoff himself responds to, and one that will be treated next, namely that prepositions are case realizations.

3.3 Prepositions as Nominal

The most prominent position on prepositions since Jackendoff (1977), and even before, is that they are directly related to morphological/grammatical case. Since cases are nominal morphology (attaching to no other base category), prepositions are taken to be fundamentally nominal because they associate only with nouns and often co-occur with different overt case marking. This kind of a perspective comes in different varieties. In some treatments, they literally *are* case affixes, and in others they are more like free-standing case forms, whose sole function is to indicate the case of the noun that they take as an argument.

Nominal approaches are important to survey because of the avenues of explanation they open up. As intimated above, if prepositions are fundamentally nominal, then the character of expotransitives change. Instead of a V-P-NP sequence, they can be characterized as a V-NP sequence, where the P is some kind of special morphology or marker on the noun. This would bring exotransitives and simple transitives together.

3.3.1 Fillmore's Original Preposition-Case Equivalence

Fillmore (1968) is the classic enunciation of the position that prepositions and cases should be considered as the same thing. The "same thing" is what Fillmore calls *K*, for "Kasus", a supercategory that circumscribes case affixes and prepositions. The argument is based on the functional similarity between prepositions and cases. This argument is revisited by nearly every subsequent author in this tradition, but Fillmore's phrasing is the most clear and elegant. He writes:

> It seems to me that the discussion of case could be seen in a somewhat better perspective if the assignment of case forms were viewed as exactly analogous to the rules for assigning prepositions in English, or postpositions in Japanese...Prepositions in English–or the absence of a preposition before a noun phrase, which may be treated as corresponding to a zero or unmarked case affix–are selected on the basis of several types of structural features, and in ways that are exactly analogous to those which determine particular case forms in a language like Latin: identity as (surface) subject or object, occurrence after particular verbs, occurrence in construction with particular

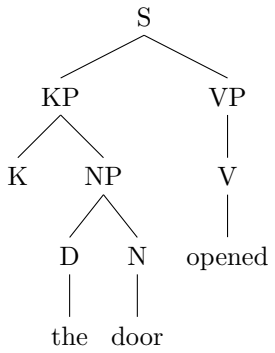
nouns, occurrence in particular constructions, and so on.

Fillmore is saying that prepositions and cases should both be considered as instantiations of K because their distribution is the same, as long as one admits the concept of a zero form. He goes on to point out two difficulties with drawing this equivalence: (a) the co-occurrence of prepositions and case affixes in the same phrase (as in (45)), and (b) there is definitive semantic content associated with prepositions that is not equivalent to or contained in case affixes.

(45) ad Rom-am
to Rome-ACC
to Rome

The problem (a) is not a problem, Fillmore says, if the process that determines cases and prepositions in languages (because they are analogous) can determine both simultaneously. He says (b) is unproblematic because a full account of prepositions/cases will allow for the choice of preposition/case to have particular semantic consequences.

Mechanically, Fillmore's system just equates particular prepositions with particular cases according to their general uses. For example, the dative case is realized in English as "to" because of its role in marking recipient roles in ditransitives, benefactive case is realized as "for" because it has a wide distribution as a benefactive marker, and so on. One of the interesting features of Fillmore's analysis occurs here. For him, *all* cases in English that are not inherent (morphologically marked) are in a prepositional relationship with their noun. Below is a tree from his article, adapted somewhat to fit contemporary phrase structure assumptions.



Even when it is a zero form, the K is deleted by a rule of "subject-preposition" deletion. There is also a corresponding rule of "object-preposition" deletion to handle zero-marked objects. Fillmore notes that this property can be suppressed by certain verbs, such that their preposition is actually realized on their object. The verbs that Fillmore has in mind here, though he never explicitly states it, are exotransitive (or similar)

verbs. In a footnote he observes that "The verb *blame*, for example, chooses ('governs') for *for* [object] and *on* for [dative]. The [object] preposition is *at* for *look* meaning 'examine', *for* for look meaning 'seek', *to* for listen, and so forth."

Fillmore's proposal is useful because, even though it is early, it is a very explicit proposal for how prepositions relate to nouns and verbs, and it also even covers exotransitives. The argumentation for prepositions as case affixes, and their mutual membership within K, is not very well justified, however. Future researchers would elaborate on it, and flesh it out in detail, beginning with Joseph Emonds.

3.3.2 Subsequent Preposition-Case Equivalences

Joseph Emonds, in his monograph *A Unified Theory of Syntactic Categories*, recounts much of Fillmore's initial proposals in the context of GB. Once again, prepositions, postpositions, particles and so on belong to a (now unnamed) supercategory. Emonds goes further than Fillmore, making conjunctions too into prepositions of a sort.

For present purposes, what is important is that case-marked NPs with no overt assigner (preposition or otherwise) are case-marked by null prepositions in Emonds' analysis. What is more, the exponence of the category (preposition or case marker) is not particularly important to Emonds. They are functionally the same.

Emonds claims that case features themselves are "projections of P". This means that an NP has case by virtue of being dominated by a projection of P. The expression of case, as mentioned, may come from case assignment by a null preposition that has a morphological manifestation, or by a preposition itself. This proposal effectively makes prepositions and cases equivalent. Prepositions and cases are both reflexes of a structural correlate (domination by a non-minimal projection of a preposition).

Emonds' proposal is considerably weaker in some respects than Fillmore and the work that comes after it. He does not make an effort to establish some similar use or semantics; where he does draw explicit equivalences between prepositions and other categories, it tends to be on the basis of structural properties. This fits well with his approach overall, which emphasizes structure rather than content.

Nevertheless, both Fillmore's and Emonds's arguments are heavily theoretical and light on empirical justification. With the shift from Government and Binding to Minimalism, the proposal that prepositions are equivalent to case shifted along with it, and in a more radical direction. The work that takes the preposition-case equivalence the farthest was done by Anna Asbury and her colleagues. In a series of papers, most prominently Asbury, Gerhke and Hegedus (2006) but also Asbury (2005) and Asbury (2008),

Asbury argues that prepositions and case markers are the same thing, full stop. As with Fillmore, she proposes a supercategory (called P instead of Fillmore's K), which subsumes cases and prepositions. Later on, P was also argued to subsume particles and locative prefixes. Yet again, the main motivation for such argumentation comes from, as Asbury puts it, "overlap in interpretation and form of cases and adpositions crosslinguistically".

Asbury uses suggestive observations from the form of Hungarian prepositions and cases towards making arguments for the preposition-case equivalence. One piece of evidence Asbury presents is that certain postpositions in Hungarian double in a particular environment (a NP with a demonstrative), just like case suffixes (46).

(46) a. en-nél a ház-nál
this-ADESSIVE the house-ADESSIVE
at this house

b. az alatt a fa alatt
that under the tree under
under that tree

These same postpositions which double like case affixes also are inflected for person and number. Case affixes receive the same inflections (modulo vowel harmony). (47).

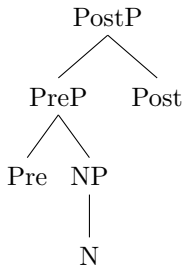
(47) a. (én) rajt-am
(PRON:1SG) SUPERESSIVE-1SG
over me

b. (én) mögött-em
(PRON:1SG) behind-1SG
behind me

She also compares these two, the postpositions and case affixes, with a class of "true" postpositions which are dissimilar on the dimensions discussed. Indeed, she goes on to point out that the postpositions that she compares to case affixes look like the "true" postpositions in other respects. Putting this all together, she then states that, because these three types of element cannot be distinguished adequately from each other (they all share certain properties, but are also all different), they should therefore be considered a single category P.

Her proposal becomes more complicated than Fillmore's in the way that she has to account for what she terms "compound cases", which are NPs where a case-marked NP and a preposition co-occur. Fillmore's remarks on such cases are covered above, and his solution is evidently not one that Asbury considers.

Nevertheless, compound cases are well known from languages such as Latin and German, but they are ubiquitous in Finno-Uralic languages and indeed languages around the world. Asbury claims that compound cases are instances of two Ps. The same case feature is instantiated on both, making compound cases an instance of doubling. This view makes them into a kind of circumposition, presumably composed of a postposition taking a prepositional complement.



Once she has made this move, her analysis of case and prepositions is as simple as positing a universal PP structure for DPs, where P is part of the extended projection of N but may be realized morphologically as a case marker or a preposition.

Asbury and Fillmore more than Emonds draw inspiration from the semantic domain shared by prepositions and case markers, and struggle in the sample place (compound cases). All three do at least remark on the case assigning properties of prepositions, and they all find convincing the functions that cases and prepositions have in common. As a result, their conclusions are largely the same.

3.3.3 Morphological and Semantic Treatments of Prepositions as Case Affixes

In an overview of cases by Martin Haspelmath (2006), he makes remarks to the effect that prepositions and cases are identical. He writes:

> There is no widely accepted cover term for cases and adpositions, but the terms "flag" and "relator" have sometimes been used as terms which are neutral with respect to the case/adposition distinction. In practice, we find considerable overlap between adpositions and case inflection. Normally adpositions are considered to be separate words, whereas case inflections are thought to be expressed by morphological means. But these means are typically invariable affixes, and such affixes may look much like short (and perhaps cliticized) words.

He continues, now remarking on the omnipresence of the conflation of cases and prepositions:

> Not uncommonly, the descriptive labels that were created for cases are also used to label adpositions, e.g. by Guillaume (2004:ch. 14) in his grammar of Cavineña, and by Kießling (1994:192-193) in his grammar of Burunge. This is perfectly reasonable, because adpositions function in much the same way as cases in languages, the main difference being that they are analytic means of expression. Thus, talking about the English "dative preposition to" or the French "genitive preposition de" is completely unproblematic (just as we can have both future-tense affixes and analytic future tense auxiliaries).

Zwicky (1992) is a prominent voice in a line of morphological inquiry into prepositions which conflates prepositions with case affixes. He begins by noting that "the equivalence of (certain) inflectional affixes and (certain) independent words is taken so much for granted that it is hard to find a clear statement of the principle...". To fill this hole, Zwicky proposes the following generalization:

> THE FUNCTIONAL EQUIVALENCE PRINCIPLE:
>
> Everything you can do with adpositions you can do with case inflections, and vice versa.

Zwicky gives some empirical justification for the functional equivalence, which is too lengthy to include here. Despite the strength of this proclamation, Zwicky does not move immediately to identifying prepositions as cases. Instead, he moves to unify the different functions of prepositions first. For this, he divides prepositions into two kinds, grammatical and local. Local prepositions are those that are used in their function as locative markers, while grammatical prepositions are those that are used, for example, to mark oblique objects. Grammatical prepositions bear case features inherently. His primary concern is grammatical prepositions.

Zwicky turns his attention to answering how grammatical prepositions and cases mark grammatical relations. He reasons that prepositions and case affixes must share some property that is responsible for this. The property he identifies is Jackendoff's [-V] feature. Grammatical prepositions are in the specifier of the NP, from where they mark the argument. As evidence that this is a sensible solution, he notes that some languages, such as Niuean, show verb agreement with adpositionally marked arguments, which is not expected if the NP is contained within a PP. This effectively makes the preposition into a part of the nominal for all grammatical prepositions.

Zwicky's analysis does more to bring prepositions and cases together. Prepositions bear cases themselves, but, bizarrely, they do not always share the case they bear with their complement nouns. As Zwicky says: "Grammatical Ps manifest one case and govern another, as when the English dative P *to* governs ACC."

In other words, the grammatical preposition *is* a case, but it also may determine a different *morphological* case on the noun. This allows prepositions a certain flexibility for Zwicky; the preposition has a case and projects it into its phrase, marking a phrase with a particular grammatical relation, but the preposition is also autonomous in that it is capable of determining other properties of its NP.

Since prepositions bear their own cases, they are like nominals in that respect, and furthermore they are like the cases themselves. They possess some other properties, but grammatical prepositions are defined principally by their case features. That such prepositions are also contained within NP gives them both a structural and morphological closeness which is also usually shared by morphological cases. Zwicky's ideas do not go nearly as far as many of the syntactic treatments do, but they do bring cases and prepositions close in an explicit way.

Wholly apart from the syntactic and morphological work on prepositions as cases, Stephan Anderson presented a theory of syntactic categories defined by their semantics in his book *A Notional Theory of Syntactic Categories*. In his theory, categories belong to major classes or are mixes of two the features which define the major classes. These features are [±P] for *predicative* and [±N] for *name*. As with Jackendoff, P and N exhaustively define the space of lexical categories. Word classes that are not lexical (tense, determiners, etc.) are called *functors*. Functors are identified with grammatical categories like case, and they are neither P nor N. The notion of functors is superficially similar to the idea of a supercategory like K for Fillmore or P for Asbury.

In Anderson's theory, prepositions express functional properties like spatial orientation and motion. Cases also express these functional properties. Because spatial orientation and motion can be expressed *without* prepositions (via cases), prepositions and cases are just two different modes of exponence for the subcategories of spatial orientation and motion. He presents the Latin examples below to show that the same semantics (motion into) can be expressed either with a case or with a preposition (48).

(48) a. Ad urb-em iit.
To city-ACC went:3S
He went to the city.

b. Rom-am iit.
Rome-ACC went:3S
He went to Rome.

Anderson's motivation for breaking prepositions and cases down in this fashion, where prepositions are possible realizations of cases (but not the only realization), is the same as for Fillmore and the other authors

so far discussed. Prepositions and cases are seen to do much the same thing syntactically (and for Anderson, semantically), and so they should just be thought of as the same thing. What is unique about Anderson's approach is that, while prepositions and cases are essentially the same, their similarity is better understood by their shared semantics rather than their comparative typological distribution or the result of their presence (case marking). This is because, for Anderson, the way they are expressed (analytically as prepositions or synthetically as case affixes) is more superficial than the fact that, cross-linguistically, both modes of expression are functionally equivalent.

3.3.4 Nominal Approaches and Exotransitives

The essence of the nominal approaches is the same across all of the work surveyed. All are motivated primarily by the functional equivalence principle. They all also have effectively the same position: prepositions are cases, at some level. The implications for exotransitives verbs are clear. If prepositions are cases, then the object of the preposition in an exotransitive is just an oblique, non-accusative object. It is analogous to well-known cases in languages like German or Latin which have certain cases of dative or genitive objects, or, more broadly, to other cases of atypically case marked arguments like quirky case marking in Icelandic. On the view, simple transitives and exotransitives also have the same structure. In some of the proposals outlined above, the preposition is located inside the NP. There would therefore be no PP intervening between the verb and the NP to interfere with licensing.

3.4 Prepositions as Verbal

The literature on prepositions as verbs is much smaller than prepositions as nouns. The logic is restricted in general to noting provocative similarities, and suggesting that there is some deeper principle which is responsible for their shared behavior. The explanation is typically confined to a shared syntactic architecture, and this unites prepositions and verbs in that they and they alone possess this kind of architecture.

If prepositions are fundamentally verbal, it is possible that they could be conceived of as a kind of auxiliary. If that were true, it would open up avenues of explanation in terms of valence-changing operations. In passivization, for example, the presence of an auxiliary verb signals the promotion of an otherwise obligatory internal argument. While it is not exactly clear how this applies in the case of exotransitives, it still suggests profitable avenues of explanation.

3.4.1 Shared V/P Properties

The first and most explicit equation between prepositions and verbs comes from Pesetsky and Torrego (2004), who set out to analyze syntactic categories and case in terms of categorical features. They argue that nominative case is in fact an instance of the feature Tense, [±T]. In the course of their analysis, they note an observation from Kayne (1984): prepositions that have objects associated with gerundives cannot have their objects extracted (49), while normal objects can be.

(49) a. Which company did she endorse __ constructing this tunnel with public money?

b. * Which company did she argue against __ constructing this tunnel with public money?

They interpret this effect as being parallel to the "that-trace" effect. The "that-trace" effect describes a situation in which the presence of an overt complementizer blocks extraction of the subject from a complement clause when it is otherwise possible without the complementizer (50).

(50) a. Who did John say __ went to school?

b. * Who did John say that __ went to school?

Pesetsky and Torrego (2004) argue that the complementizer *that* is actually an argument bearing the feature [T], and its presence blocks extraction because it occupies the escape hatch of the lower clause (Spec_CP) due to prior T-to-C movement. When it is absent, another, lower phrase can occupy this position. Pesetsky and Torrego hypothesize, by analogy to the P-trace case, that the inability to extract from PP has the same cause: P is a "species" (their term) of T, and so it moves up to a C in its domain. This prevents extraction. To bolster their conclusion, they point out that the vocabulary of prepositions is often found in the aspectual domain (51).

(51) a. John considers there **to** be many reasons for this.

b. Mary kept there *from* being a riot.

They use the shared properties of V and P to argue that prepositions are really like a type of verb, although at no point do they recount any of Jackendoff (1977)'s similar suggestions. They conjecture that verbs and prepositions are united by the way that language is found to unite temporal and spatial expressions. Though Pesestky and Torrego (2002) offer this speculation, their unification of prepositions and verbs is mechanically only as deep as syntactic structure.

3.4.2 Shared P/V Structure

Den Dikken arrives at the idea that prepositions and verbal at some level completely separately. He develops thinking that began with Van Riemsdijk (1990) and then was extended considerably by Koopman (2000). This line of research concerns the functional domain associated with prepositions, and it reaches conclusions that support the notion that prepositions are associated with fairly elaborate functional structure. This is done in order to account for the existence and operation of Dutch prepositional modifiers and the intricate details surrounding Germanic ambipositions.

Den Dikken's main contribution is to make specific equations between the functional layers above P and the functional layers above V. The functional projections above P, PlaceP and PathP, correspond to verbal aspect. Degree modifiers of P correspond to Tense. Both categories also have Agreement projections through which they mediate syntactic relations with their arguments. Den Dikken's motivation for this move is to provide a more thorough account of the structure of PPs in such a way that P might be easily assimilated into the recognized lexical categories (N, V, A). Again, the primary contribution and motivation is in terms of syntactic structure.

The analyses by Den Dikken and Pesetsky and Torrego are as far as the conflation of prepositions with verbs goes. Compared to the wider and more ambitious literature that conflates prepositions with the nominal domain, this literature is both less unified and less bold.

3.4.3 Verbal Approaches and Exotransitives

The verbal approaches are not very specific, but to the extent that they are, they are potentially useful. Like Jackendoff, they emphasize abstract similarities between prepositions and verbs. The takeaway from the work of Pesetsky and Torrego and Den Dikken is that prepositions could be a kind of verbal form by themselves. If that is the case, then it is possible that the preposition is like an auxiliary verb. Auxiliary verbs and verbs interact in the syntax to produce valence-changing results, like in passives, and so the analogy of prepositions to auxiliary verbs is promising. If auxiliary verbs can reduce the valence of a verb, then they should also in principle be able to increase the valence. Prepositions - if they are like auxiliary verbs - would fill that role.

3.5 Overview of Prepositional Category and Exotransitives

Starting with Jackendoff (1977), analyses of the place of prepositions within a broader theory of syntactic category have disagreed on their characterization. There is no need to adopt either of the nominal or verbal perspectives in their entirety. Indeed, it is clear that they are neither entirely nominal nor entirely verbal.

What is important for the study of exotransitive verbs are the facts that each camp emphasizes. On the nominal side, the Functional Equivalence Principle emphasizes that prepositions are predominantly *functional* in nature. Nominal approaches downplay locative and otherwise more lexical cases of prepositions. Instead, they view prepositions as a kind of nominal marker. on the verbal side, the fact most emphasized is the importance of argument taking. This is the fact that Jackendoff is most impressed with, and it is the syntax of prepositional argument taking which Pesetsky and Torrego are most interested in.

The facts emphasized within the two approaches are not inconsistent with each other. In fact, they appear to be easily related: prepositions license nouns, and mark them in a way that is not altogether different from case marking. At the same time, however, these facts not sufficient to conclude that prepositions are either nominal or verbal in any real sense. Both nominal and verbal approaches highlight important characteristics of prepositions, but they do not motivate a pure equivalence.

The functional nature of prepositions and their licensing capabilities prove to be of paramount importance. Licensing and marking are the only way to understand preposition/verb relationships in argument structure and exotransitives in particular. With this in mind, I move on now to surveying the literature on argument structure and then exotransitives. The literature on these subjects specify ways in which marking and licensing of prepositions are integrated with those functions of verbs. Understanding the ways that they may be integrated is the first step towards being able to extract the generalizations that unite exotransitives and simple transitives.

3.6 Linking Prepositions within Argument Structure

The literature on argument structure is vast. Much of it is also on English, which is notable for the use of prepositions to map arguments that may also be introduced by the verb. The dative alternation (52a-b) is just one example. I have given two more examples, the comitative alternation (52c-d) and the instrumental alternation (52f-g) below as well.

(52) a. I gave some soup to our guests.

b. I gave our guests some soup.

c. Josh and Rick met.

d. Josh met with Rick.

e. We shot a popgun at the statue.

f. We shot the statue with a popgun.

Such alternations are typically thought to have the same truth values, and so they represent different ways in which syntactic structure can be mapped to a common semantic representation. Beyond that, argument structure alternations also involve prepositions in a unique way: the lexical identity or even the presence of prepositions may be affected. The preposition functions at some critical level in concert with the verb to ensure that it is saturated with the correct number of arguments with the appropriate semantics.

The mechanics behind prepositional alternations in argument structure appear to be a phenomena related to the occurrence of prepositions in exotransitives. A verb that can license a nominal object may also permit that object to be licensed by a preposition. If the conditioning factors or constraints on the preposition licensing an argument for the verb can be understood, they would provide insight into exotransitive verbs. In broader terms, argument structure alternations communicate critical ways that prepositions may relate to verbs and arguments.

The first direct account of how verbs integrate prepositional information comes from Marantz (1984). Marantz makes note of some of the problems already noted, namely that verbs appear to be able to interact with nouns that are the complements of prepositions. A simple and well-studied example is theta assignment into preposition phrases in the dative alternation.

(53) a. John gave a ribbon to Mary.

b. John gave Mary a ribbon.

Although the recipient is the object of the preposition (*to*), it nevertheless receives a role which the verb quite obviously assigns in the double object variant of the construction. The implication of this alternation is that it is the verb which comes with the theta-grid specifying a theme and recipient, and *to* is more or less devoid of responsibility for the marking of the recipient role. This is not to imply that there are no differences between the prepositional and double object[4], only that for the purposes of theta marking they are not different.

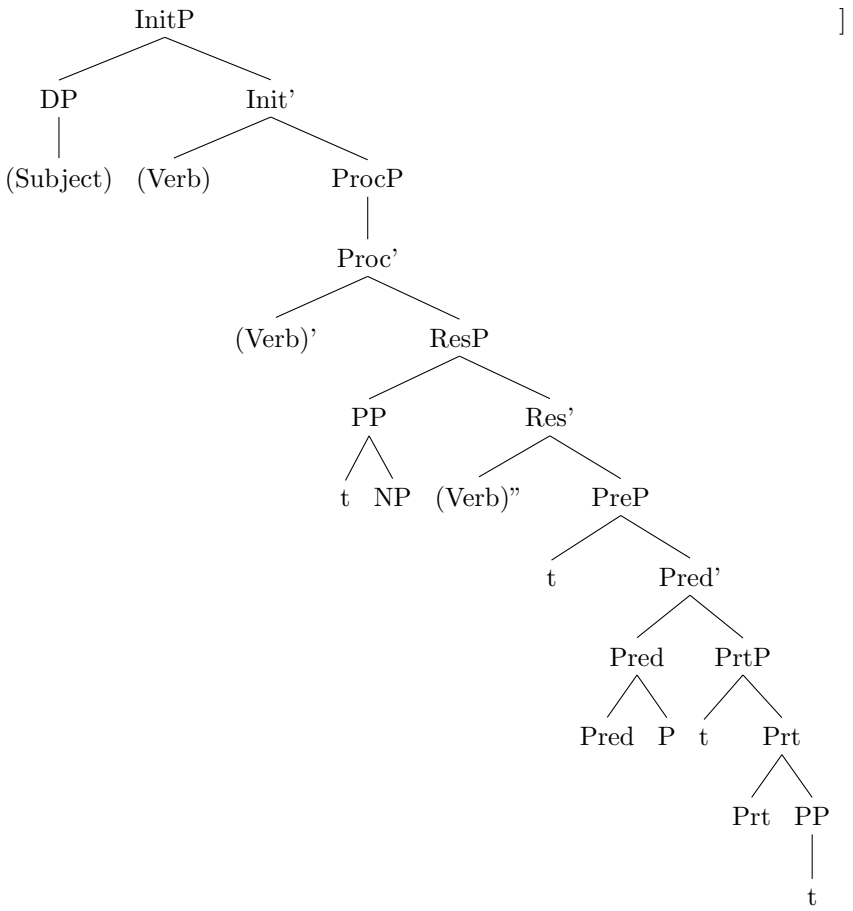
[4]cf. Pinker (1989) and Bresnan et al. (2007) for extensive discussion on the causes and consequences of the variants.

This evident fact is not easy for Marantz to harmonize with the tradition in which he is writing. For him, role assignment is accomplished under sisterhood between a role assigner and the eventual role bearer. The intervention of the preposition precludes this relationship, and so the problem must be solved by other means. Marantz does this by proposing that the verb possesses a theta role for the recipient and the theme, while the preposition also is capable of assigning a recipient role. In the double object variant, the verb accomplishes theta marking in more or less the typical manner. In the prepositional construction, the verb indexes its recipient role with the preposition, which theta marks its own object. The process of indexing excuses the verb of its responsibility for marking the recipient, and the result is well-formed.

A very different approach was taken by Ad Neelman, with antecedent work in Hestvik (1991). In Neelman (1997), he adds theoretical machinery to early Minimalism to make a verb's inherent theta-grid generalizes to prepositional structures. So, while Marantz' approach links prepositions and verbs through indexes, Neelman assumes a pre-existing theta-grid associated with the lexical entry of a verb and an operation of theta-linking to connect verbal argument structure to prepositional phrases. The linking operation can be thought of similar to Marantz' indexing, where the role assigned by the preposition is matched with a role on the verb.

Finally, there is one further extensive, preposition-focused work that provides a detailed framework for how prepositions combine with verbs in argument structure, Tungseth (2008). Following the groundwork laid by seminal work by Levin and colleagues (Levin 1993; Levin & Rappaport Hovav 2005), Tungseth's investigation goes into considerable depth on the semantics of different prepositional phrases. She explains how the semantics of verb-preposition collocations is established with respect to telicity and spatial orientation.

The principle behind her system is simple: heads in the syntax which bear properties related to verbal material, like prepositions, must locally associate with them in the course of a derivation through syntactic movement. Mechanically, however, her proposal for how prepositions and verbs unite is quite complicated. Prepositions which meet conditions on relatedness with the predicate (support a benefactive/recipient, for example) are joined with verbs by associating with phrases in the syntax. Tungseth adopts a Ramchandian decomposition of VPs into three functional projections, InitP (initiation), ProcP (procedure) and ResP (result). Over the course of the derivation, the verb associates with the (null) heads of each of these projections by head movement, and the arguments, both core and oblique, associate by phrasal movement with the specifiers of these null heads. The concept behind her derivation is shown in the tree below.



Prepositions that are associated with Result (like English *into*) go into the specifier of ResP; prepositions associated with Procedure (but do not imply an endpoint like English *towards*) go into the specifier of ProcP, and so on. In this way, prepositions and verbs are related structurally and in the course of a derivation. Verbs realize the categories Init, Proc, and Res, as are commensurate with their semantics, and so they must associate with those heads in the course of the derivation. Prepositions *also* relate to those categories, but they introduce the arguments that eventually are to be assigned that particular role. For example, a NP which realizes the endpoint of some motion needs to be in the phrase with a preposition that has endpoint semantics, but it also needs to be connected to the verb, and it does that through PP phrasal movement to the requisite position while the verb occupies that head. The success of this account is of course modulated by the rules of interpretation that operate over the resultant structure, but outside of that it does specify a way in which prepositions and verbs interact to produce mappings of arguments. Prepositions link the argument to the verb through a Spec-head relationship in the course of a syntactic derivation.

I have surveyed three different linking approaches in this section. All have the same basic essence, even if they differ in the details. Predominantly, the idea is that a syntax relationship must hold at some point in

the derivation in order for the verb to be satisfied. For Marantz, it is a simple index of the kind that holds between a fronted head and its trace. For Neelman, it is an actual syntactic mechanism ("linking") that relays thematic information from a preposition back to the verb. For Tungseth, it is a complicated series of phrasal movements in an elaborated functional structure.

I will ultimately make a commitment to a particular mechanism in Chapter 5, but the mechanisms of argument structure are only part of the picture. There are existing treatments of exotransitives in the literature which include some suggestions for how the prepositional information is integrated with the verb. I move on to discussing those now.

3.7 Exotransitive Verbs

3.7.1 Exotransitive Prepositions are Cases

A familiar treatment comes from Joan Bresnan, in her LFG treatment of complementation (Bresnan 1982). In her framework, prepositions are identified with cases, although not as strongly as in Fillmore's or Asbury's work. For Bresnan, prepositions are identified with the unique set of cases, such that prepositions are lexically associated with the case(s) they may assign. Thus, *by* assigns agentive, *to* locative case, and so on. In this way, the objects of such prepositions are oblique with a particular case, notated as OBL_{case} (so, OBL_{agent}, $\text{OBL}_{patient}$, and so on). This is fairly typical, except for the proclivity in LFG to identify grammatical roles with cases. That is to say, while the GB/Minimalist literature notates case as a purely formal object, cases are more akin to semantic roles for Bresnan.

Bresnan extends this notion to the case of exotransitive verbs. She does not treat them in detail, but she acknowledges their existence as a phenomenon of English complementation. Her identification of prepositions with cases struggles to account for why the object of the preposition in an exotransitive does not bear the typical role that such prepositions frequently assign. The problem is that the object of *by* is not agentive (or proximal[5], or instrumental, or temporal, as it also may sometimes be) in (54b) though it is still marked by *by*.

(54) a. The ball was kicked by the boy

b. The children abided by the instructions given them by the teacher.

[5]That it is not proximal is shown by modification possibilities. Modification of spatial *by* is possible by an adverb like *almost* in concrete spatial terms *the office almost by the park* or in abstract terms *the kinds were almost by themselves.* However, *almost* is marked with *abide by* when *almost* modifies the preposition (**The children abided almost by the instructions...*). It is possible when the adverb takes scope over the VP however (*The children almost abided by the instructions...*)

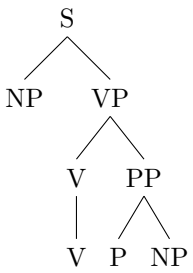
In order to get around the problem posed by exotransitive verbs (which Bresnan calls "idiomatic"), Bresnan proposes to locate an oblique argument slot on the verb. The corresponding preposition is the item which will fulfill that. Consequently, the preposition appears due to a lexical property on an exotransitive verb *abide by* as OBL_{BY}, and so on for all similar cases. This solution implies that there is a semantic role identified uniquely by being marked by a preposition in an exotransitive like *depend on*, but only when it is used idiomatically.

Unlike the solutions proposed in the argument structure literature, Bresnan's analysis implies that the preposition is linked to the verb's requirements lexically. The mechanics of this outside of LFG are not entirely clear, but the principle is comprehensible in any case. For Bresnan, the link between exotransitives and the prepositional information is lexical in origin.

3.7.2 Exotransitive Prepositions are Contentless

Hestvik (1991) discusses theta role assignment to prepositional objects in the context of exotransitive verbs. Hestvik's concern is how roles that are associated with the verb come to be born by prepositional rather than verbal objects. His solution is akin to Marantz (1984) and Neelman (1997), where verbs assign theta roles either by means of or just entirely through prepositions.

In the context of theta assignment, Hestvik discusses the three types of relationship a preposition may have with a verb: as an adjunct, as an argument, and then as a complement. Adjunct prepositions assign their own roles, while argument prepositions (like the obligatory PP argument of a verb like *put*) receive a role from the verb which they subsequently pass on to the NP. Hestvik approaches exotransitives differently, however. Instead of being used as a vehicle for theta assignment, the prepositional component of an exotransitive is entirely transparent to it, with the verb assigning its role directly to the prepositional object.



Hestvik justifies this move by appealing to the apparent unpredictability of the preposition from the lexical semantics of the verb. He claims that this means that the preposition and verb are non-compositional. Thus, the preposition assigns no theta role. Within his system of theta assignment, this amounts to saying that

the preposition in an exotransitive is not only contentless but effectively part of the verb itself (though in what way, he does not say). That is why it is possible for the preposition to be transparent for the purposes of theta assignment.

The outcome of the mechanism that Hestvik is advanced, then, is similar to a strict preposition-case equivalence. The preposition is not its own projection or autonomous head, meaning that the verb has direct access to the noun. No information needs to be mediated or communicated through the preposition.

3.7.3 L-selection

When the topic of prepositional syntax became central to David Pesetsky's 1995 book *Zero Syntax*, he made an attempt to capture the relationship between the verb and the preposition in an exotransitive. The problem which motivates Pesetsky's solution is the problem of capturing the consistency in form of the second internal argument in ditransitive constructions (being almost always *to*, or sometimes *for*).

In GB/Minimalist syntax, a universal binary branching structure limits a head (in this case, a verb) to only a single complement. Complements have privileged properties in GB/Minimalism, like the ability to be have certain of their properties determined by their selecting head, like syntactic category and some semantic features. The direct object is the complement of the verb, from which it receives (at least) its a theta role. However, in the case of ditransitives, there is both a direct object and an indirect object. The indirect object must also receive its theta role, which comes (as per Marantz (1984)) from the verb's theta grid. However, the indirect object in ditransitives must instead receive the recipient role from the dative preposition *to*, since the indirect object is the complement of *to* and not of the verb. The problem is how to account for the fact that the prepositional complement in a case like the dative *to* has properties typical of a verbal argument (e.g, has a verb from its theta grid).

Pesetsky's solution is a mechanism he calls "l-selection". In essence, Pesetsky says that a predicate has the ability to select a particular lexical item for the purpose of assigning a θ role iff that lexical item is capable of assigning a role that the predicate itself requires. This mechanism results both in the mediation of role assignment and the presence of a particular preposition. Pesetsky is then able to extend this notion to exotransitive verbs, such that the verb itself l-selects for the preposition.

In practice, l-selection is just a GB/Minimalist implementation of Bresnan (1982)'s lexical association for the purposes of dependent marking. While Bresnan formalizes the requirement as for a particular role which must be marked by a particular preposition, Pesetsky couches the necessity of the preposition in terms of selection. By the time Pesetsky was writing, selection as a mechanism had already been divorced from

argumenthood by Grimshaw (1991) when she extended it to semantic features with s-selection. Therefore, selection was not for arguments necessarily, and could extended to specific lexical items. The force of both a lexical requirement and selection are identical: the preposition must occur for the resultant expression to be well-formed. In the end, however, it is unclear exactly how l-selection solves the problem of providing prepositional information to the verb. Hypothetically, the selection mechanism could be enhanced in such a way that the role that the preposition has to assign could be foisted on it by the verb, but this is not explicitly spelled out.

3.7.4 Unification in the Semantics

The sole detailed HPSG analysis of exotransitive verbs belongs to Stephen Weschler in his 1995 work *Preposition Selection Outside the Lexicon*. Like many of the other authors already surveyed (Marantz, Pesetsky), he is concerned with the broad question of how preposition-verb association is accomplished, and so he primarily addresses verbs where the selection appears to be semantically motivated. These are cases like verbs of speaking, which take *to* with extreme reliability.

Weschler's handles the regularity preposition-verb associations like *rely on, denude of* etc. with the interaction of semantic composition rules and pragmatic constraints. (55a) is well-formed because the combination of the semantics of *sing* and *for* yield a well-formed semantic representation, while *sing* and *onto* in (55b) do not.

(55) a. John sang for the crowd.

b. * John sang onto the stage.

Weschler contends that it is not the semantics of the verb which are rendered incomplete without the preposition, but rather that without the correct preposition, the rules which form a semantic representation from a syntactic one will be ill-formed if the preposition has the wrong semantics. Since semantics is built compositionally, the meaning of a VP will be composed of the V and the complement PP. A preposition which does not specify the semantic role that the action of the verb requires will result in an unfilled role, and so the expression is ill-formed.

Weschler's solution retains a property of other solutions that have already been covered, namely that somewhere within the lexical entry of the verb is a requirement for a role that may (and sometimes must) be assigned by a preposition. This approach is highly reminiscent of Bresnan's. The main difference is in how the association between a preposition and verb is accomplished. He points out that the presence of a

preposition without recipient semantics in the case of a prepositional ditransitive for example, will lead to a sentence without a recipient. And if recipients are obligatory for the semantics of the verb, then the result will obviously be ill-formed. The same goes for other types of verbs.

When this proposal is extended to exotransitive verbs, it is considerably less clear in application. Weschler claims that with exotransitive verbs like *hanker after, long for*, among others, the lexical entry for *hanker* comes specified for a PP headed by *after*. It places the requirement for the preposition into the lexical entry, which was something he was unwilling to do for ditransitive verbs. This kind of an analysis is consistent with his explanation for ditransitive verbs because there is a distinction between verbs which have optional additional roles and those which have obligatory roles. His explanation for the ill-formedness of preposition-verb associations like (55b) works only if there is a mismatch in the role needed by the verb and the one belonging to the preposition. If the verb does not *need* the role, then there can be no ill-formedness resulting from a bad combination of preposition and verb. But if the verb needs the role, then it will only be rendered by a single preposition, and that preposition must be represented in the COMPS list of the verb.

3.8 Summary

I began this chapter by arguing that a synthetic approach was the most appropriate for unifying exotransitivies and simple transitives. I furthermore argued that the only way to make progress in understanding what causes exotransitives and simple transitives to differ was to study prepositions in depth. To that end, I surveyed existing theoretical treatments of prepositions as a category and concluded from them that there are two facts of serious importance. First, prepositions are functional elements. Second, prepositions can license arguments.

From there, the problem becomes how the prepositional information (its functional information and information about the argument is licenses) gets united with the verbal information. This is exactly what has to happen in exotransitives in order for them to be unified with simple transitives. I surveyed several mechanisms that could unite prepositions and verbs in that way. One comes broadly from the literature on argument structure, and the rest are suggestions from the literature on exotransitives. The possibilities are summarized below.

- **Linking**: a syntactic relationship is established between the verb and preposition in the derivation. This relationship allows for the communication of prepositional information to the verb (Marantz 1984; Neelman 1997; Tungseth 2008).

- **Lexical Relationship**: the verb has a pre-established lexical relationship with its dependent preposition which specifies the kind of information that the prepositional dependent will bear. The prepositional information is unified with the verb at a higher level than the syntax. (Pesetsky 1991; Bresnan 1982).

- **Semantic Unification**: no requirement is imposed on the verb for any prepositional complement to appear. Any prepositional information is unified at the level of semantics. Only well-formed semantic representations can be output, so deviant combinations are ruled out *de facto*.

In the next chapter, I will unveil more properties of exotransitives verbs. These properties will narrow down the possible mechanisms that could be responsible for bring prepositional information to the verb.

CHAPTER 4

The Lexical Representation of Exotransitives

4.1 Exotransitives at the Lexical Level

At the beginning of Chapter 3, I argued that better understanding of prepositions would lead to a better understanding of exotransitives. Two conclusions were particularly relevant: prepositions are primarily functional in nature, and they may license arguments. I reviewed several possible ways in which functional prepositions which license arguments can relay information about their argument to the verb. The correct way to conceptualize the sharing of information between the preposition and verb is not yet evident. In this chapter, I will propose a way in which this is done. In particular, I will be arguing that prepositions and verbs in exotransitives share a structured lexical representation. The proposal I make shares the general insights behind Bresnan (1982)'s approach (and to a lesser extent Pesetsky (1991)'s), although it is quite different in implementation.

I support this conclusion with a series of sentence processing experiments using exotransitive verbs. The results of these experiments argue that information about the preposition is available at the verb. Mechanically, this implies that lexical access of the verb is simultaneously also lexical access of the preposition. Only if the preposition and verb shared a lexical representation of some kind would that be possible. From there, I apply the insights of the previous chapters toward sketching how the preposition shares information about its argument with the verb.

4.2 Background on Prediction in Language Processing

Much preceding research has found evidence that the parser makes predictions about upcoming material in the course of generating a parse. Here *prediction* refers to any behavior by the parser in which hypotheses are generated concerning upcoming material based on information in the left-context (specific words, features, grammatical roles, etc.) (Kimball 1973; Schneider 1999; Crocker 2002; Lau et al. 2006). Research has shown that semantic (Federmeier & Kutas, 1999; Meyer & Federmeier, 2007; Wlotko & Federmeier, 2007), morphosyntactic (Van Berkem et al., 2005) and phonological (DeLong, Urbach, & Kutas, 2005) features

of upcoming words are anticipated. What is notable about these studies, and others (Kutas & Hilyard 1984; Delong, Urbach & Kutas 2005; ; Knoeferle et al. 2005), is that the anticipation concerns some particular upcoming word(s), from the information in the left-context. This effect has been interpreted as *local* prediction, i.e, the particular source(s) of information that generate the prediction (the *predictor*) and the thing that is predicted are adjacent or nearly adjacent. Semantic information (Boland et al. 1989, Boland et al. 1995), lexical information (MacDonald, Perlmutter & Seidenberg 1994, Altman & Kamide 1999), and discourse context (Spivey & Tanenhaus 1998) have all been shown to affect prediction of the upcoming word.

Of particular concern, however, is *syntactic* prediction, since that is the domain of concern for exotransitives. The first study to argue for truly syntactic prediction was Staub and Clifton (2006). They investigated reading of sentences containing *either...or* to see whether encountering *either* and its following phrase would facilitate processing of *or* and subsequent material. They found that reading of the disjunct introduced by *or* was facilitated when *either* was present, compared to when it was absent. Facilitation was detected regardless of whether the disjunct was a sentence or a noun phrase. This facilitation is expected if the parser built a parallel structure, because the only information that the parser has about the content of the second disjunct to cause facilitation is the structure of the first disjunct. This finding indicates that the parser used the fact that *either* co-occurs with a disjunction *or* to anticipate a disjunction structure.

Subsequent work by Yoshida, Dickey and Sturt (2013) found more evidence that the parser predictively builds detailed upcoming structure. They showed sentences with an elliptical construction known as sluicing (Ross 1967, Merchant 2001), where an embedded wh-phrase introduces a missing clause that is interpreted as a wh-question of a preceding clause (56a). Importantly, the embedded wh can also introduce a different clause unrelated syntactically to the preceding clause (56b).

(56) a. John told some stories, but we couldn't remember which stories (John told).

b. John told some stories, but we couldn't remember which stories Mary was impressed with.

At the point of the wh, a sluicing parse is possible, meaning that the sentence could conclude at the wh with the elliptical sluicing interpretation. Yoshida, Dickey and Sturt hypothesized that the parser might choose a sluicing parse at the point of the wh. As a consequence, the parser would copy the structure of the antecedent clause into the embedded clause. To test this, they showed participants sentences with preceding contexts with a gendered name, and then included in the embedded wh a reflexive pronoun that either matched or did not match in gender with the previous name. They also showed participants sentences that were not compatible with sluicing as a control, by using an incompatible pied-piped preposition

They hypothesized that if the parser built a sluicing structure predictively, there would be a gender mismatch effect at the reflexive because the parser had anticipated a sluicing structure and copied the antecedent clause with the mismatching gendered name. Thus, it would attempt to connect the reflexive it had encountered with the gendered name in its predicted clause. Consistent with this prediction, Yoshida, Dickey and Sturt found longer reading times when the gender mismatched with the name only when sluicing was possible, indicating that the parser was predicting that the embedded wh-clause was associated with a sluicing structure.

4.3 Syntactic Prediction with Exotransitives

In the course of processing, the sentence parser has to access the lexical representation associated with input it has received and segmented (Marslen-Wilson & Welsh 1978; Sweeney 1979). Thus, in a sentence like (57), when the parser hits *rejected*, it has access to something like the representation given in (58) in addition to the syntactic representation which it has built up to that point.[1]

(57) The oversight committee rejected...

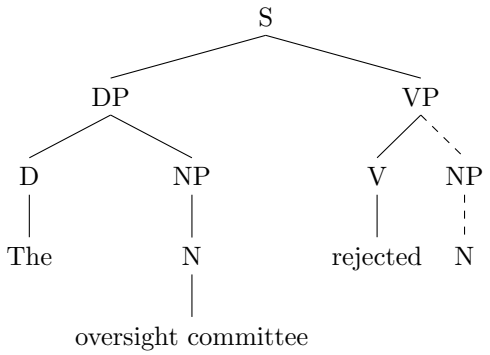
(58)

$$\begin{bmatrix} \textit{rejected} & \\ \textsc{cat} & \text{verb} \\ \textsc{tense} & \text{past} \\ \textsc{voice} & \text{active} \\ \textsc{mood} & \text{indicative} \\ \textsc{akt} & \text{telic} \\ \textsc{sel} & \begin{bmatrix} \textsc{subcat} & \langle \text{NP} \rangle \\ \theta & \textsc{Theme} \\ \textsc{case} & [\textsc{acc}] \end{bmatrix} \end{bmatrix}$$

From (58), it uses *reject*'s SUBCAT information to predict a following NP, leading to a parse like (59).

(59)

[1] Different traditions have different commitments to the type and specificity in a lexical entry. Though I use attribute-value matrices throughout this dissertation, I am not thereby committing myself to any particular tradition. Whatever framework that they can be translated into is fair game. For my purposes, they are a detailed and elaborated representation that is both sufficient and convenient for my purposes.



The parser uses information like that in a lexical entry's SUBCAT to make predictions about upcoming material. Studies on syntactic predication (Staub & Clifton 2006; Philips 2006; Yoshida, Dickey & Sturt 2013) have demonstrated that the parser builds syntactic structure anticipatorily. In this context, *anticipatorily* means that the parser builds predicted structure into its broader parse prior to seeing confirmatory bottom-up input.

The situation is fairly easily demonstrated for simple transitives like *reject*. The parser references the SEL properties in (58) made available to it during lexical access, which it leverages to anticipatorily project the NP, as shown in (59). Consider now the exotransitive case. Suppose first that the exotransitives bear no specification for their prepositional phrase in their lexical entry (they are intransitive in this sense) (60).

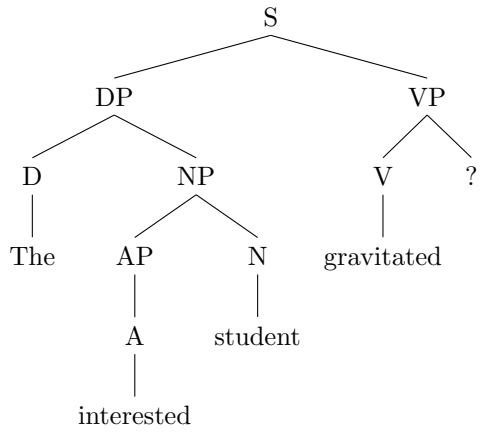
(60) a. The interested student gravitated...

b.

$$\begin{bmatrix} \textit{gravitate} & \\ \text{CAT} & \text{verb} \\ \text{TENSE} & \text{pres} \\ \text{VOICE} & \text{active} \\ \text{MOOD} & \text{indicative} \\ \text{AKT} & \text{atelic} \end{bmatrix}$$

In the case illustrated in (60), there is no SEL information that the parser can use to generate predictions. Consequently, the parser will not be able to generate any predictions about upcoming material.

(61)



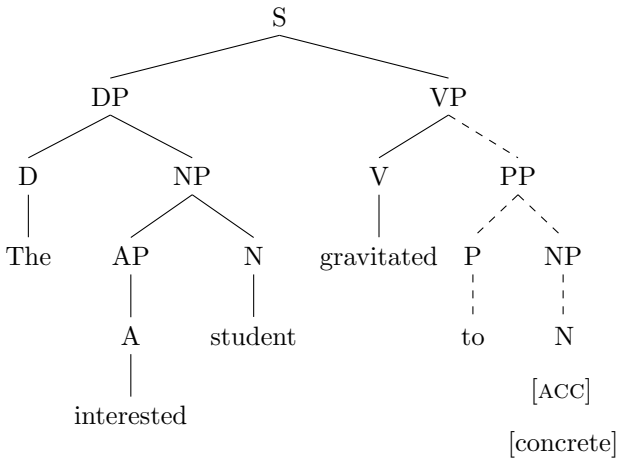
On the other hand, if prepositions and verbs have a structured lexical representation in common, information about the forthcoming preposition is readily available upon recognition of *gravitate*. What's more, information about what follows the preposition (a nominal complement) is available. Critically, all of this information (about the preposition and about possible complements of the preposition) is available at the (uniqueness point of the) verb. Consider a structured representation like (62) which includes information about the preposition.

(62)

$$\left[\begin{array}{ll} \textit{gravitate to} & \\ \text{gravitate} & \left[\begin{array}{ll} \textsc{cat} & \text{verb} \\ \textsc{tense} & \text{pres} \\ \textsc{voice} & \text{active} \\ \textsc{mood} & \text{indicative} \\ \textsc{akt} & \text{atelic} \\ \text{to} & \left[\begin{array}{ll} \textsc{cat} & \text{prep} \\ \textsc{subcat} & \left\langle \text{NP}_{[+concrete]} \right\rangle \\ \theta & \textsc{Theme} \\ \textsc{case} & [\textsc{acc}] \end{array}\right] \end{array}\right] \end{array}\right]$$

Because the lexical entry for *gravitate* also includes *to* and all properties unique to it, the parser should be able to predict *to* and build all structure associated with it at the point of *gravitate* (63).

(63)



A lexical representation like (62) allows not only much of the following structure but also specific properties of the nominal argument to be predicted. Exotransitives are thus an acute case where the parser can make very detailed predictions about upcoming material as long as the lexical representation of an exotransitive includes information about the preposition.

Before proceeding, it is worth considering the possibility that the parser might have information about the preposition at the verb for reasons other than a common lexical representation. The most significant possibility is that speakers could use n-gram information - namely, the high conditional probability of the preposition on the verb - to achieve the same result as lexical access of the preposition at the point of the verb. The problem with invoking n-grams is twofold. The first is that the preposition can be dissociated by an arbitrary distance (theoretically speaking), and yet the definite grammatical relationship between the verb and its preposition would still obtain at any distance. N-grams being limited by their size - and the computational infeasibility of storing n-grams of arbitrary size - makes this solution unworkable. The other problem is that invoking n-grams in this way proves too much. It would expect the same effect for a combination like *spy with*, where the preposition *with* is an instrumental adjunct. The phrase is nevertheless quite frequent as part of the idiom *spy with my little eye*. A simply n-gram mechanism fails to make a distinction between grammatically relevant verb-preposition combinations in exotransitive verbs and grammatically irrelevant but nonetheless frequent ones like *spy with*. And in the end it is the *grammatical* relationships that are relevant for predicting upcoming information.

Given that simple n-grams will not be able to accomplish the same task as syntactic prediction, the task becomes to distinguish between (60b) and (62). If the verb has no information about the preposition then it will not make predictions concerning the preposition or the complement of the preposition. If it does have

this information, then it will not only predict the preposition and the position of its complement, but it will be able to leverage that position in processing.

4.4 Filler-Gap Dependency Resolution and Prediction

Following previous work, I assume that when the parser has a filler, it will attempt to find a gap site for it as soon as possible (Stowe 1986; Frazier & d'Arcais 1989; Traxler & Pickering 1996; Philips 2006) so that it can unburden working memory as soon as possible (Gibson 1998). If the parser attempts to resolve a dependency in a location that is occupied, then processing difficulty is incurred. Processing difficulty of that kind is known as a filled-gap effect (FGE). The parser actively attempts to resolve a dependency wherever possible, as soon as possible (Traxler & Pickering 1996, Aoshima et al. 2004, Omaki et al. 2015). This process is known as "active search".

A representation like (62) provides the active search mechanism with the opportunity to anticipatorily build and attach the PP. Within this PP, it can also project the NP complement position of that PP at the point of the verb. At the point of the verb, then, the parser has identified an NP position but does not know what the head of that phrase is. If a filler has been presented in the left-context (such as a *wh*), the parser could resolve the dependency in the NP position is has identified. According to active search, the parser acts to resolve a dependency wherever possible, as soon as possible. The NP position it identifies in the complement of the PP of an exotransitive verb counts is just such a position. Since the PP is available at the point of the verb by hypothesis, the parser should therefore resolve the dependency inside the NP complement of the PP. On the other hand, if the verb lacks any information about the preposition, then the parser will not have any information that it can use to project a new NP position. Consequently, the parser cannot resolve the dependency at the point of the verb.

Normally, the different predictions of lexical representations like (60b) and (62) cannot be distinguished. However, they are testable when the exotransitive verb and its associated preposition are separated. As I showed in Chapter 1, exotransitive verbs are well-formed when the preposition is separated from the verb. This is in spite of their relatively low dissociation rates - the latter is a *descriptive* fact about use, rather than a condition on well-formedness. So, while dissociation is uncommon in production, it is still possible modulo factors like size and category of the intervening constituent(s). So, importantly, adjunct PPs can separate the exotransitive verb from its preposition. Consider a sentence like (64). Although they are somewhat difficult, such sentences are indeed well-formed, as confirmed by a norming study which is described in Section 4.1.2 below.

(64) The campaign which$_i$ the detective snooped for the rival party discreetly on t_i was judged innocent.

When the exotransitive is separated from its associated preposition, the parser knows there is an upcoming PP. Since the parser builds structure anticipatorily, it will project the upcoming PP as well as the NP position inside that PP. These predictions lead to a situation where the parser has predicted an upcoming gap site (the NP inside the PP) at the point of the verb. According to active search, it will resolve the dependency there prior to seeing any additional information. The critical situation occurs when the exotransitive is separated from its associated PP by an adjunct PP. Adjunct PPs are capable of hosting gaps in English, and so they are possible sites to resolve a dependency. If the lexical representation of exotransitive verbs contains information about the associated PP, the parser will not attempt to resolve the dependency in an adjunct even though it is a possible gap site. This is because it has already resolved the dependency inside the site it predicted. Conversely, if the verb and preposition are not associated, then it will not predict the PP at the verb. As a result, the intervening adjunct is the first possible gap site that parser locates, and it will attempt to resolve the dependency in that position.

4.5 Experiments

Three experiments were run. The first and second experiments used eye-tracking, and were run on an EyeLink 1000 eye-tracker. The last experiment was run using a word-by-word self-paced moving window task (Just, Carpenter, & Woolley, 1982). The experiments were meant to investigate the way that the parser attempted to fill gaps inside argument and adjunct prepositional phrases.

4.5.1 Experiment 1

4.5.1.1 Participants

Forty-eight native speakers of English participated in an eye-tracking experiment. All were students at Northwestern University. They received credit for their participation.

4.5.1.2 Design & Predictions

Twenty-four sentences were prepared using exotransitive verbs. Each sentence contained the associated preposition and an adjunct prepositional phrase. In 2x2 factorial design, the type of PP that immediately followed the verb (argument vs. adjunct) and type of the wh-phrase (NP vs. PP) were manipulated as independent factors.

(65) a. **Postverbal Argument / Preposed NP** The campaign which the detective snooped for the rival party discreetly on was judged innocent.

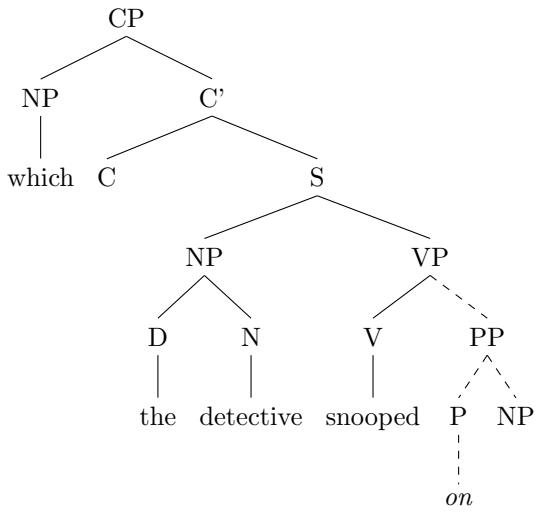
b. **Postverbal Adjunct / Preposed NP** The campaign which the detective snooped on the rival party discreetly for was judged innocent.

c. **Postverbal Argument / Preposed PP** The campaign for which the detective snooped on the rival party discreetly was judged innocent

d. **Postverbal Adjunct / Preposed PP** The campaign on which the detective snooped for the rival party discreetly was judged innocent

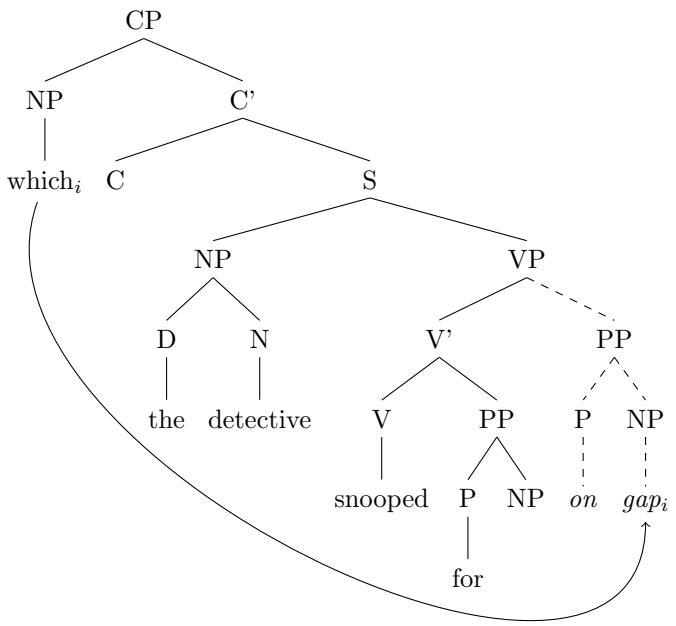
The region of interest is the PP immediately following the verb, because it is the first gap site observed by the parser, and hence the location where a FGE might be observed. The parser can anticipate the associated preposition when it hits the verb if exotransitive verbs contain information about their prepositions. From there, it can build the PP structure of the preposition, and identify the potential gap site in the complement of that preposition, (66).

(66)



The first gap site it encounters is the one in the predicted but as yet unseen argument PP. Because that is the first gap site it encounters, it should resolve the dependency in that site even though it has not seen it by that point. Consequently, if it hits a postverbal adjunct PP, it will not attempt to fill the gap (posit a trace and bind the wh to it) in that position. This is because it has already filled it inside the anticipated argument PP.

(67)



As a result, there will be no FGE (and thus no slowdown) upon finding the adjunct PP filled. Conversely, if the verb does not contain information about the preposition, it will attempt to the fill the gap in the first position it finds, no matter whether the argument PP is first or the adjunct PP is first. FGEs should be observed in both cases with preposed NPs.

We verified the stimuli with an off-line acceptability judgment task. 40 native English speakers rated the experimental sentences (given in Appendix D) on a 7-point scale using Ibex Farm (spellout.net/ibexfarm/). The participants were recruited over Amazon Mechanical Turk, and were paid $2 for their participation. The experimental stimuli were presented in a Latin square design along with 168 filler sentences. The mean judgment on experimental sentences was 3.43. The ratings were analyzed with linear mixed effects regression. There was no significant difference of associating the wh with the argument or adjunct (3.36 vs. 3.50, $p>.29$). There was a significant difference of pied-piping versus stranding; pied-piping was less acceptable than stranding (3.20 vs. 3.65). This is to be expected, as pied-piping is the marked construction.

The stimuli were also verified with the corpus study presented in chapter 2. The results for the particular

prepositions used are given in Table 1 below.

Table 4.1: Co-occurrences in the BNC

Verb	Preposition	Co-occurrence
barge	in	0.5775862
commune	with	0.8888889
delved	into	0.7453730
capitalize	on	.8000000
depend	on	0.8884294
emigrate	to	0.5767045
gape	at	0.8200000^2
interfere	with	0.6898179
lapse	into	0.5318352
marvel	at	0.7500000
masquerade	as	0.8846154
pander	to	0.9387755
partake	of	0.8076923
participate	in	0.7814570
preside	over	0.6738661
prey	on	0.6455696
react	to	0.5810463
rely	on	0.9427525
renege	on	0.9059829
reside	in	0.5741557
revel	in	0.8783784
snoop	on	0.4130403
tamper	with	0.9290780
assent	to	0.7123287
Mean		0.7442336

The mean preposition occurrence is 74%. To put this number in perspective, the average preposition occurrence of the selected obligatory verbs in the BNC is only 43%. Based on these verification studies, we can conclude two things. First, the extraction from adjuncts and arguments are not different in their acceptability, and so any differences in reading times should not be influenced by relative acceptability. Second, the prepositions in our stimuli are highly predictable from the verbs.

4.5.1.3 Procedure

The test sentences were ordered randomly with 96 filler sentences, using a Latin Square design. Participants received five practice trials prior to beginning the experiment, and they answered a comprehension question after each trial. The comprehension questions tested comprehension of the critical region (embedded V, PP, Adv, P).

4.5.1.4 Results

Mean comprehension question accuracy was 83%. Three participants were excluded for low (<70%) accuracy. Accuracy scores did not differ significantly between conditions. Fixations greater than 2000 ms were excluded, as were reading times (re-reading time, first-pass reading time, regression path duration) greater than 3000 ms (5.6% of total data), and any times less than 80 ms (μ=834, σ=494 for total fixation time for all regions). Linear-mixed effects regression was performed on residualized log reading times with the maximal appropriate random effects structure, including crossed item and subject effects (Barr et al. 2013). The final model tested effects of position (pied-piping/stranding) and postverbal PP type (argument/adjunct). Including co-occurrence frequency of the verb and preposition did not significantly improve the model, and so it was dropped.

There were effects of pied-piping early in the sentence. Rereading times were slower at the wh in stranding cases (β=0.29, t=3.57, p<.001), and then also at the embedded subject determiner (β=0.29, t=2.64, p=.009). There was also a marginal effect of rereading time at the embedded verb; the rereading time was lower in the adjunct condition (β=-0.15, t=-1.99, p=.047). This reason for this difference is probably not homogeneous. Rereading times at the embedded verb in the argument condition probably come from regressions at the adjunct preposition, due to the expected positioning of the argument preposition. Conversely, rereading times at the embedded verb in the adjunct condition probably come from surprise at the preposition being an adjunct with the verb, because adjuncts are less expected than arguments. Given that the causes of the regressions are plausibly different, there is little reason to expect that their consequences should require the same amount of time to resolve, leading to an ultimately not meaningful observed difference.

At the critical region, the postverbal PP, there were significant differences in regression path duration at the adjective inside the PP-internal NP. There was a main effect of the immediately postverbal PP being an adjunct versus an argument. That effect (β=0.29, t=2.39, p=.017) shows longer regression path durations at the adjective when the postverbal PP was an adjunct versus an argument. However, there was also an interaction between these factors (β=-0.43, t=-2.57, p=.012), indicating that postverbal adjuncts in the stranded case were read significantly faster than expected. Figure 2 shows regression path duration for the critical comparison (Postverbal Argument / Stranded vs. Postverbal Adjunct / Stranded) at the adjective. A higher regression path duration can be interpreted as processing difficulty. The most plausible source of that difficulty comes from the parser attempting to posit a gap inside the postverbal PP. Despite the parser's propensity for positing gaps wherever possible, a contrast was found between adjunct and argument

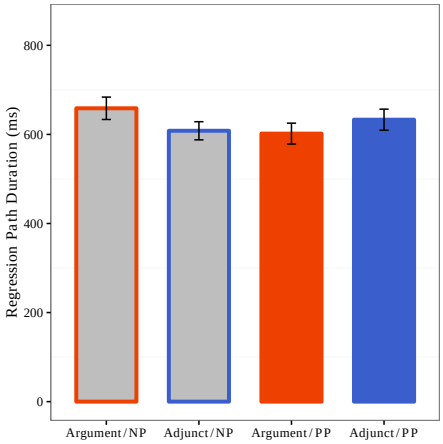


Figure 4.1: Mean regression path duration at the critical region. Postverbal Argument conditions are in red, Postverbal Adjunct conditions are in blue. Unfilled bars are Preposed NP, filled bars are Preposed PP conditions.

prepositional phrases in regression path duration. The postverbal adjunct PP was read faster than the postverbal argument PP.

4.5.1.5 Discussion

There was a significant difference in the critical comparison for regression path durations at the adjective inside the immediately postverbal PP. The regression path duration at the adjective inside the argument PP was significantly longer than inside adjunct PPs. This finding can be interpreted as a filled gap effect for the argument PPs, since regression path durations are commonly associated with processing difficulty, such as with garden path sentences (Konieczny 1996, Liversedge et al. 1998). However, there was no filled-gap effect for adjunct PPs.

The lack of processing difficulty when the postverbal PP was an adjunct suggests that the parser was not positing a gap in that position. The findings are only consistent with the idea that the lexical representation of the verb included information about the preposition, which caused it to be built in advance. Because PP information is available at the point of the verb, the parser would be capable of filling the gap before it hits the adjunct PP. Then, the parser resolved the dependency inside that PP. A follow-up experiment was conducted to support the interpretation of the findings of the first experiment.

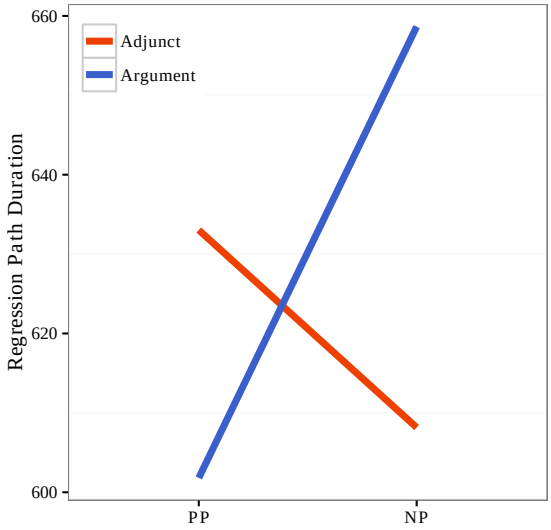


Figure 4.2: An interaction plot, showing the change in mean regression path duration from the control conditions (Preposed PP) to the critical comparison (Preposed NP). The change in means change direction.

4.5.2 Experiment 2

The results of the first experiment lead to the conclusion that the verb and preposition are associated with a structured lexical representation. The parser can leverage the information in that representation for structural prediction. If this account is correct, a prediction follows. Specifically, if the parser sees an exotransitive verb, then identifying a gap in an immediately postverbal adjunct PP will cause processing difficulty. Effectively, this is the reverse of the previous experiment. The parser has already filled the gap in the argument PP at the point of the verb, and so if it finds the gap elsewhere (the adjunct PP) prior to seeing the argument PP, it will be surprised. We used a self-paced moving window task to test this possibility.

4.5.2.1 Participants

Thirty-three native speakers of English participated. All were students at Northwestern University. They received credit for their participation, and the experiment lasted approximately 25 minutes.

4.5.2.2 Design & Predictions

Twenty-four items were prepared based on the items used in Experiment 1. As before, each sentence contained the associated prepositional phrase, and an adjunct prepositional phrase. In 2x2 factorial design, the type of PP that immediately followed the verb (argument vs. adjunct) and type of the wh-phrase (NP vs.

PP) were manipulated as independent factors. Unlike Experiment 1, however, the preposition that hosted the gap was immediately postverbal in the stranded cases.

(68) a. **Argument First/ Preposed NP** The campaign which the detective snooped on hardly discretely for the rival party was judged innocent.

b. **Adjunct First/ Preposed NP** The campaign which the detective snooped for hardly discretely on the rival party was judged innocent.

c. **Argument First/ Preposed PP** The campaign on which the detective snooped hardly discretely for the rival party was judged innocent.

d. **Adjunct First/ Preposed PP** The campaign for which the detective snooped hardly discretely on the rival party was judged innocent.

By placing the preposition that hosted the gap immediately adjacent to the verb in the stranded cases, the parser is put in a position where it can evaluate its prediction immediately. In other words, the first gap site it encounters is the true location of the gap. As a result, when the parser hits a postverbal adjunct preposition that hosts a gap, the parser will be surprised if and only if it has actually filled the gap elsewhere. The parser would only have do that if it had predicted the argument PP, which occurs because the verb includes information about the preposition in its lexical entry. Thus, the prediction view expects that there will again be a contrast between the conditions, but in the reverse direction: the parser will be surprised to find an immediately postverbal adjunct hosting the gap, but not a postverbal argument.

Admittedly, the parser could suffer from a plausibility effect at the adjunct preposition, because of the inherent unpredictability of adjuncts. Even so, some effect of plausibility is to be expected on any view. The parser would still compare the plausibility of each preposition postverbally, but I reason that this should not influence its ability to identify either preposition as the actual gap site. The reasoning for this is that active search leads the parser to posit a gap wherever possible. Given that the postverbal adjunct is a potential gap site, the parser should be able to identify the gap in a postverbal adjunct PP just as well as a postverbal argument PP. So when the parser identifies a gap, it should fill it without difficulty in the same way that it would fill any gap, and the difference in processing difficulty can be measured in the spillover adverbs.

As before, an off-line acceptability judgment task was conducted to ensure that differences in acceptability would not confound the results. 68 native English speakers rated the experimental sentences (given in the appendix) on a 7-point scale using Ibex Farm. The participants were recruited over Amazon Mechanical Turk, and were paid $2 for their participation. The experimental stimuli were presented in a Latin square

design along with 168 filler sentences. The mean judgment on experimental sentences was 3.21. The ratings were analyzed with linear mixed effects regression. There was no significant difference of associating the *wh* with the argument or adjunct (3.11 vs. 3.31, p>0.16). Unlike previous experiments, there was no significant difference of pied-piping versus stranding (3.20 vs. 3.22, p=0.80).

4.5.2.3 Procedure

The test sentences were ordered randomly with 96 filler sentences, using a Latin Square design. Participants answered a comprehension question after each trial.

4.5.2.4 Results

Mean comprehension question accuracy was 78%. Accuracy scores did not differ significantly between conditions. One item had to be eliminated from the analysis due to a typographical error. Reading times greater than 2000 ms were excluded, and any times less than 100 ms (for all data, μ=440, σ=235). Linear-mixed effects regression was performed on the residualized log reading times with the maximal appropriate random effects structure. As before, including co-occurrence frequency of the verb and preposition did not significantly improve the model fits, and so it was dropped from the model. Figure 4 depicts the reading times for each region for all conditions.

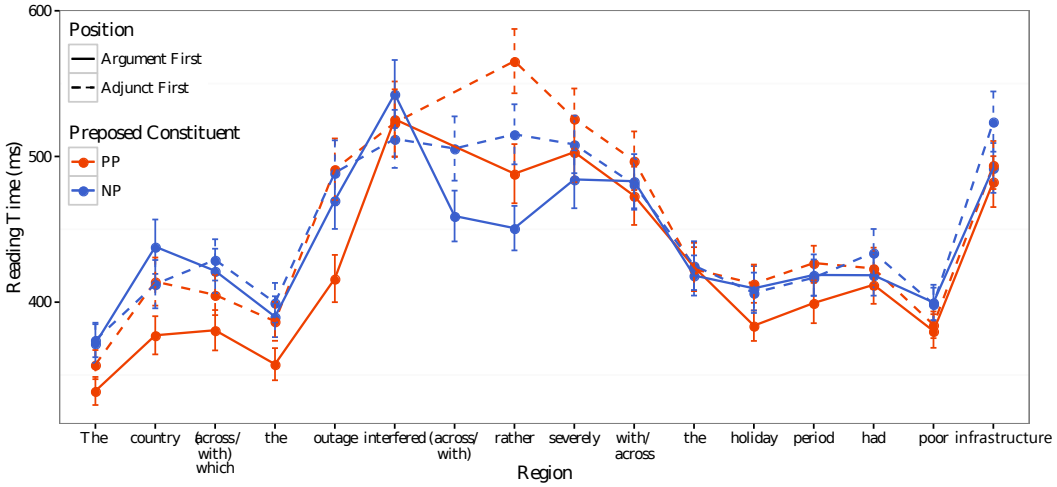


Figure 4.3: A region by region plot of reading times.

The particularly high reading times in the pied-piped/adjunct first condition indicate processing difficulty, likely driven by the same surprisal at finding a preposition that mismatches with the typical prepositions

associated with the verb. This finding is echoes the higher cumulative regression path duration in the pied-piped/postverbal argument condition in Experiment 1.

At the critical region, the critical comparison was between the stranded conditions at the spillover adverbs. There was a significant difference in both conditions in the first spillover region (Pied-piped vs. Stranded: β=-0.08, t=-2.61, p=.009; Argument First vs. Adjunct First: β=-0.11, t=-3.42, p<.001). Pied-piped sentences were read more slowly than stranded sentences, most likely reflecting surprise spilling over from the parser encountering a verb with which the pied-piped preposition is not an argument, although the interaction did not reach significance. More importantly, the spillover adverb after adjunct prepositions which hosted the gap was read significantly slower than the spillover after argument prepositions hosting the gap. This indicates the parser's surprisal at finding a gap in the adjunct preposition. There were no significant differences at the second spillover adverb. Slower reading of the spillover regions in the Adjunct First condition corresponds to a "reverse filled-gap effect", where the parser was surprised when it identified a gap in the adjunct position. This finding is consistent with the parser having information about the preposition at the point of the verb in order to predict structure, which it would only be able to do if the preposition and verb are part of a structured lexical representation.

4.5.2.5 Discussion

The experiment was designed to test a prediction of the idea that lexical access of an exotransitive verb leads to corresponding lexical access of a preposition. This was tested by observing reading times for sentences where the gap site immediately followed the verb in either an argument or adjunct preposition. The finding of a reading time slowdown on the spillover regions is again consistent with the prepositional information being available at the verb. The slowdown on the spillover regions indicates the parser's surprise at finding a gap in the adjunct. If the parser passed over the adjunct position in the first experiment because it found the parse of the filler with the argument preposition more plausible or because of a statistical bias for extraction from that position, then the results are not easily explained. The parser should not fail to correctly associate a filler with its actual gap site on such an explanation.

There is one final possibility to consider at length. The reading times on the spillover regions might be longer in the Wh with Adjunct / Stranded condition because the parser is holding the lexically associated preposition in working memory, and waiting for it to be seen so it can release it. The working memory cost associated with holding the preposition might cause increased reading times on the adjunct and the spillover adverbs as the parser spends more and more time with the preposition in working memory. This

is implausible for two reasons. The first is that reading times should increase the farther along the parser goes without hitting the preposition, but the opposite is the case (as depicted in Figure 4). The difference in reading times between the conditions actually decreases from the first spillover adverb to the second. The second reason this is implausible is that the same effect would have been detected in the first experiment at the postverbal adjunct PP. The postverbal adjunct separates the verb from its associated preposition, and so if it was the separation between the verb and the preposition which causes processing difficulty, then the reading times on the adjunct should be longer than on the argument, contrary to fact.

This leaves only one explanation for the results of the experiment. The parser's surprise from finding a gap comes from having already filled the gap elsewhere, at the point of the verb. The parser would only do this if it built the PP structure (and the NP structure inside that PP) anticipatorily. It would only do that if prepositional information was available at the verb.

4.5.3 Implications

The results the experiments are best explained as the parser making use of prepositional information on the verb to predict a PP structure which it can use to resolve the dependency anticipatorily. Although I have already made suggestions about the way that prepositional information would be available at the verb, it is reasonable to ask what that information is, and how is it structured. In Chapter 3, I dismissed selection and idioms as satisfactory for capturing the relationship between the preposition and its exotransitive. As a result, they cannot be entertained here. Instead, the verb and preposition have to be associated in a different way. One way they may be is associated is through containment. To see what I mean, take the example of *gravitate to* given in (69).

(69)

$$\left[\begin{array}{ll} \textit{gravitate to} & \\ \text{gravitate} & \left[\begin{array}{ll} \textsc{cat} & \text{verb} \\ \textsc{tense} & \text{pres} \\ \textsc{voice} & \text{active} \\ \textsc{mood} & \text{indicative} \\ \textsc{akt} & \text{atelic} \end{array}\right] \\ \text{to} & \left[\begin{array}{ll} \textsc{cat} & \text{prep} \\ \textsc{subcat} & \left\langle \text{NP}_{[+concrete]} \right\rangle \\ \theta & \textsc{Theme} \\ \textsc{case} & [\textsc{acc}] \end{array}\right] \end{array}\right]$$

In a representation like (69), the verb contains the preposition, which includes also its subcategorization and thematic information. This is different from selection for a number of reasons, but most saliently, it allows the preposition to specify something it selects. So far as I know, other selection mechanisms do not specify or otherwise allow the selected constituent to select something further. Containment like (69) is more than sufficient for the results of the experiment, since it would allow the parser to predict not only the upcoming preposition but its specific lexical identity and even semantic and grammatical features of the preposition's complement.

As far as I can tell, combining lexical entries like (69) has not been previously proposed. It bears some resemblance to the suggestion by Bresnan (1982) that exotransitives specify the lexical identity of the preposition and the corresponding role it will take. However, (69) goes farther. A the lexical entry for a word (*to*) is contained entirely within another word (*gravitate*). Is it really necessary to include the preposition in its entirety? It seems so. Without specifying the preposition and its properties in their entirety, there is no information about the NP or its properties which become available to the parser. The only plausible simpler alternatives are (selection and idioms) are empirically inadequate.

With this in mind, I will devote the remainder of this chapter to explaining how the structured lexical entry works. In particular, I will explain how it allows prepositional information to become available to the verb in the course of the derivation.

4.6 Implementation in the Lexicon and the Syntax

The lexical representation that I have argued holds of exotransitive verbs requires some explanation. Contemporary minimalist syntax imagines that, in building a well-formed output according to the syntax, the syntactic derivation begins with a theoretical construct known as the NUMERATION (Chomsky 1995). The numeration is the set of lexical items that will participate in the derivation. Thus, the numeration for a sentence like (70a) will be (70b).

(70) a. The cat got stuck in a tree.

b. N = { the, cat, tree, stuck, in, a, got }

The numeration is populated from the lexicon. The content and identity of lexical items are copied into the numeration, from which items will be selected and placed into the syntactic derivation.

The main issue in implementing a lexical representation that contains two lexical items is that the correspondence between lexical items and members of the numeration is one-to-one. That is, in forming the

numeration in (70b), for example, the numeration has copied the lexical representation of *cat, tree, in*, etc. in the lexicon, and that is how the item is represented in the numeration. The name is merely a convenient stand-in for the more complex feature matrix that fully identifies the item. Each item in the numeration will occupy a terminal node in the syntax.[3]

Where a problem emerges is with the population of the numeration. An exotransitive lexical entry has two heads that both need to be represented as individual items in the numeration, since they both must occupy terminal nodes of phrases they themselves project. However, as far as copying from the lexicon into the numeration is thought to operate, the copying procedure is strictly literal. Literally copying a lemma like *gravitate to* like (69) is that there are two feature matrices embedded in it, which both must come to occupy terminal nodes. Consequently, an exotransitive verb and its preposition will come in to the numeration bundled together.

(71) a. The herbivore gravitated to the greenery.

b. N = {the, herbivore, greenery, gravitated}

c.

$$\mathrm{N} = \left\{ \begin{bmatrix} \textit{the} & \\ \textsc{cat} & \mathrm{D} \\ \textsc{sem} & \textsc{def} \\ \textsc{subcat} & \langle \mathrm{NP} \rangle \end{bmatrix}, \begin{bmatrix} \textit{herbivore} & \\ \textsc{cat} & \mathrm{N} \\ \textsc{num} & \mathrm{sing} \\ \textsc{case} & \textsc{nom} \\ \textsc{sem} & \mathrm{concrete} \\ \textsc{subcat} & \langle\rangle \end{bmatrix}, \begin{bmatrix} \textit{greenery} & \\ \textsc{cat} & \mathrm{N} \\ \textsc{num} & \mathrm{mass} \\ \textsc{case} & \textsc{acc} \\ \textsc{sem} & \mathrm{concrete} \\ \textsc{subcat} & \langle\rangle \end{bmatrix}, \begin{bmatrix} \textit{gravitate to} & \\ \mathrm{gravitate} & \begin{bmatrix} \textsc{cat} & \mathrm{verb} \\ \textsc{tense} & \mathrm{pres} \\ \textsc{voice} & \mathrm{active} \\ \textsc{mood} & \mathrm{indicative} \\ \textsc{akt} & \mathrm{atelic} \end{bmatrix} \\ \mathrm{to} & \begin{bmatrix} \textsc{cat} & \mathrm{prep} \\ \textsc{subcat} & \langle \mathrm{NP} \rangle \\ \theta & \textsc{Theme} \\ \textsc{case} & [\textsc{acc}] \end{bmatrix} \end{bmatrix} \right\}$$

Insertion of a lexical item from the numeration into the syntactic derivation is done wholesale, and the preposition and verb are never "unpacked" from each other. Consequently, syntactic derivations with exotransitive verbs will always fail.

While the problem is certainly real, there is a danger of taking representations like those in (71c) too literally. There is no literal or figurative containment by the entry *gravitate* that prevents the copying mechanism from seeing both items when populating the numeration. There are several conceivable ways of solving this problem. The one adopted here is that there is an instruction to the copying mechanism on what to copy, which is executed at the lexicon-syntax interface. The copying mechanism as defined in (72) would operate on an exotransitive like (73) to populate the numeration of (74) with both verb and preposition.

[3]Except perhaps for the influence of head movement, the representation of which is contentious in any case.

(72) NUMERATION COPY: Copy the feature matrix with index i into the numeration.

(73)

$$\begin{bmatrix} \textit{participate in} & \\ \text{COPY-INDEX} & \textcircled{1}\,\textcircled{2} \\ \text{participate} & \begin{bmatrix} \text{CAT} & \text{verb} \\ \text{TENSE} & \text{pres} \\ \text{VOICE} & \text{active} \\ \text{MOOD} & \text{indicative} \\ \text{AKT} & \text{atelic} \\ \text{INDEX} & \textcircled{1} \end{bmatrix} \\ \text{in} & \begin{bmatrix} \text{CAT} & \text{prep} \\ \text{SUBCAT} & \langle \text{NP} \rangle \\ \theta & \text{THEME} \\ \text{CASE} & [\text{ACC}] \\ \text{INDEX} & \textcircled{2} \end{bmatrix} \end{bmatrix}$$

(74) a. Everybody participated in the inauguration.

b. N = {everybody, participated, inauguration, the, in}

While this mechanism may at first seem to be *ad hoc* as well, I will revisit it significantly in Chapter 7. Additionally, it is useful beyond just exotransitive verbs. It generalizes to other collocations, which are confronted with a similar problem. For example, all parts of an idiom must enter the numeration together, and they cannot inhabit an atomic lexical entry, at least for the reason that they can be syntactically flexible (Nunberg, Sag & Wasow 1994). However, psycholinguistic studies have also argued that they are represented as whole units in the lexicon (Swinney & Cutler 1979). So the same problem appears: how can all parts be guaranteed to inhabit the numeration, while they still have a separate representation in the lexicon? If they have a representation similar to what was proposed for exotransitive verbs, the problem is not difficult. Consider the example below.

(75)

$$\left[\begin{array}{ll}
\textit{cross the line} & \\
\textsc{copy-index} & \textcircled{1}\,\textcircled{2}\,\textcircled{3} \\
\textsc{cross} & \left[\begin{array}{ll}
\textsc{cat} & \text{verb} \\
\textsc{tense} & \text{pres} \\
\textsc{voice} & \text{active} \\
\textsc{mood} & \text{indicative} \\
\textsc{akt} & \text{atelic} \\
\textsc{subcat} & \langle \text{NP} \rangle \\
\theta & \textsc{Theme} \\
\textsc{index} & \textcircled{1}
\end{array}\right] \\
\text{the} & \left[\begin{array}{ll}
\textit{the} & \\
\textsc{cat} & \text{D} \\
\textsc{subcat} & \langle \text{NP} \rangle \\
\textsc{index} & \textcircled{2}
\end{array}\right] \\
\text{line} & \left[\begin{array}{ll}
\textsc{cat} & \text{N} \\
\textsc{case} & [\textsc{acc}] \\
\textsc{num} & \text{sing} \\
\textsc{index} & \textcircled{3}
\end{array}\right]
\end{array}\right]$$

In this way, the lexical entries of exotransitives and perhaps collocations generally can be represented together in the lexicon but assured to have all their constituent parts in the numeration.

4.7 Summary

In this chapter I proposed a particular type of lexical representation for exotransitive verbs. Since the human sentence parser actively predicts upcoming material based on lexical information, it could be used to diagnose whether or not exotransitive verbs contain information about their associated prepositions. In two sentence processing experiments, the prepositions and information about their complements was predicted by the parser. This indicated that detailed information about the preposition is available at the verb.

I dedicated the remainder of the chapter to discussing what the appropriate lexical representation of exotransitive verbs is, and how it can be implemented in the lexicon and the syntax. I proposed that the preposition is contained within the verb's lexical entry. I concluded with a discussion of how the containment allows for prepositional information to be shared with the verb in the syntax.

CHAPTER 5

Syntactic Analysis of Exotransitives

5.1 The Licensing Problem

Since concluding that exotransitive verbs are a legitimate class of English verbs, the focus has been on understanding what the relationship between the preposition and the exotransitive verb is. At the end of Chapter 4, I argued that the exotransitive verb and the preposition are related by a lexical entry which contains both the verb and preposition. The preposition contains the role specification and subcategorization information for the internal argument. Correspondingly, the verb bears no responsibility for the internal argument.

This situation is on the surface quite unlike that of simple transitives. Simple transitives are thought to contain all of the necessary thematic and subcategorization information for licensing the internal argument themselves. If my central claim is correct - that exotransitives and simple transitives are fundamentally the same - it is unclear why exotransitive verbs use a preposition to license their internal argument. Simple transitive verbs license their internal arguments themselves; indeed, it is their very hallmark. Simply put: if exotransitives are transitive, why should they need a preposition to accomplish what simple transitive verbs do on their own? Why would they not be able to take their object directly, like simple transitives? I will call this the "licensing problem".

This chapter is dedicated to overcoming the licensing problem. To do this, I will argue that the problem suffers from a mistaken premise. In fact, *no* verbs license their arguments, at least not directly. Verbal arguments are instead always taken by a separate head. One type of head that can license the internal argument is a preposition, giving rise to exotransitive verbs in the process. In the case of simple transitives, the head is null. Exotransitive verbs are therefore exceptional only in that they have an overt manifestation of the head that licenses the internal argument.

A vast literature explores the idea that verbs do not take their internal arguments directly. As far back as Chomsky (1991), projections that mediated the relationship between the verb and the internal argument have been postulated, termed agreement (Agr) projections. In syntax, these were abstractions of the split-Infl

hypothesis (Pollock 1989), in which syntactically active but phonologically null heads carried out essential functions like agreement. In their generalized form, agreement projections were used to induce movement out of VP and check features (Johnson 1991; Hale & Keyser 1993; Chomsky 1995; van Hout 2004). In this way, internal argument licensing had already been taken (at least partly) out of the hands of the verb. This kind of view has been elaborated on many times, with authors giving different degrees of responsibility to the functional projection. By Chomsky (1995), the agreement projection responsible for the internal argument (AgrO) had been reformulated as the "light verb" v and given lexical expression in strings like *They did$_v$ the laundry.*

Work into AgrO-like heads in syntax persists. Bowers (2002; 2010), for example, makes extensive empirical arguments for a functional projection (Tr) medial to vP and VP which determines transitivity. Whatever it is called, such proposals have commonalities that it will be useful to extract for the coming discussion. In particular, some functional head is responsible for assigning case and possibly a theta role to the internal argument. This functional head may be null (call such a case $\mathrm{F}_\emptyset$). Finally, at some point in the derivation, the internal argument associates locally with (either in the specifier or as the complement of) the projection of F.

Returning to the licensing problem, the application to exotransitives is straightforward. If the preposition heads the agreement projection, lexicalizing it in the process (call it F_P), then there is a solution to the licensing problem. I will proceed by assuming that F_P and $\mathrm{F}_\emptyset$ are both in fact members of category P (referred to as P_p and $\mathrm{P}_\emptyset$ respectively). There may be empirical reason down the line to draw a distinction between them; unless and until such a reason is presented, however, they will be treated as one and the same. Indeed, an extensive literature in generative syntax has invoked null prepositions in a variety of contexts to solve argument licensing problems (Baker 1988; Den Dikken 1995; Boeckx & Lasnik 2003 *inter alia*). In the end, both transitives and exotransitives have their internal arguments licensed structurally in the same way - by an P head that does the work of selection, case and possibly theta assignment.

There are obstacles to this overly simplistic picture, however, whatever the particulars of the theoretical standing and syntactic particulars of $\mathrm{P}_\emptyset$. There are two ways that a straight identification of $\mathrm{P}_\emptyset$ with P is unsatisfactory. In the first place, this identification is stipulated and not demonstrated - in other words, on what grounds (other than convenience) can it be said that $\mathrm{P}_\emptyset \approx \mathrm{P}_p$? Secondly, there is no clear explication of the properties of $\mathrm{P}_\emptyset$ that make an identification necessary.

Nevertheless, the possibility that another head is responsible for licensing the internal argument of transitives - and also exotransitives - is undeniably useful for overcoming the licensing problem. Identifying P -

in exotransitives and more broadly - as a functional head that licenses the internal argument overcomes the asymmetry in licensing naturally and straightforwardly. But a simple stipulation of that identification lacks depth. To make use of this kind of a proposal, the proposed solution must be explored in more detail. And then, there also needs to be a way to understand how the objects of P are interpreted as internal arguments. Finally, it would also be ideal if there were some way to explain why P behaves as a functional head in exotransitives, showing up overtly, and why it is not overt in simple transitives. In the next section, I discuss the framework that I adopt for answering these questions.

5.2 Exoskeletal Argument Structure

Primarily, what is needed is a flexible approach to the licensing of internal arguments that is agnostic about the categorical identity of the licensing head. A class of approaches to syntax, argument structure, and the syntax-lexicon interface are so-called "exoskeletal" approaches. In particular, the proposals of Borer (2005a; 2005b) and Distributed Morphology (DM) (Halle & Marantz 1993; Harley & Noyer 1999) share a number of operating assumptions that come together in a way that allow the desiderata to be met. In the outline below, I will focus on the senses in which they are similar and useful for present purposes.

5.3 An Outline of Exoskeletal Lexico-Syntax

The central tenet of exoskeletal syntax is that the interface between what is truly lexical - what grammatical information is indexed to the memory trace of a word - and what is truly grammatical is minimal [1]. Words are not tuples of semantic, grammatical, and phonological information. Instead, a word is a pair of phonological and conceptual "real-world" information as in Borer (2005a; 2005b) or a pair of phonological information and a syntactic context as in DM. The lexicon is restricted more or less to the index that links these two within the human language faculty. This means that the properties that a lexical item appears to have, like number or transitivity or gender, are determined by structural context. Applied to the phrasal and sentence level, the meaning of a string is not *determined* by the properties of the lexical items that occupy terminals in a well-formed structure. Meaning is instead *constructed* according to the syntax and structural context.

To see what this means for argument structure, consider the two (simplified) structures of (76), (77) and (78). (77) depicts an endoskeletal syntactic tree assuming that lexical items are tuples of semantic, syntactic, and phonological features drawn from an elaborated lexicon *a la* Chomsky (1995)[2]. The feature

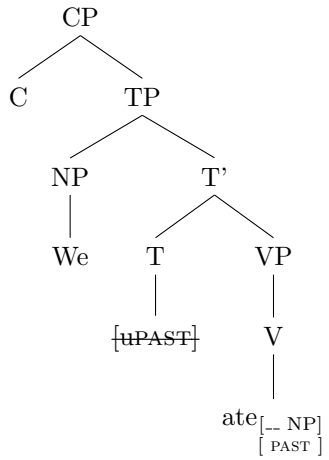
[1] This tenet is also shared somewhat by Construction Grammar.

[2] Late Government and Binding would show *eat* in the terminal of V, with the form *ate* derived via head movement of V to

bundle, depicted bearing the relevant selectional feature that concerns the licensing of the internal argument ([__ NP]), is located at the terminal node of VP. (78) on the other hand is exoskeletal, with morphosyntactic features realized in the surrounding structure, and which relate to the lexical item *eat* in that way. These features are not present at the terminal node of VP. The difference is subtle but highly significant. What this means as far as transitivity and argument structure goes is as follows. In (77), the verb *ate* really *is* transitive, it just has no internal argument in this particular instance. By contrast, it is not even possible to frame that concept in (78). A verb like *ate* is transitive if it occurs with some functional structure (like an agreement projection) that licenses an internal argument. Since no such structure occurs in (78), *ate* is intransitive in this instance.

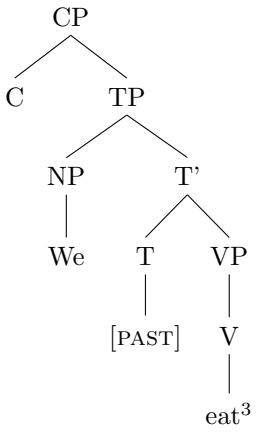
(76) We ate.

(77) (Endoskeletal)



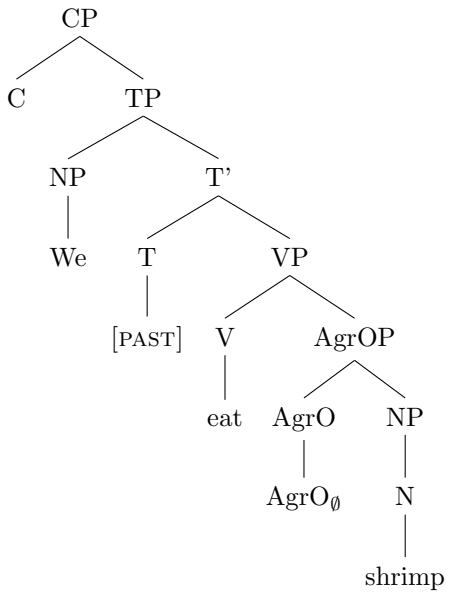
(78) (Exoskeletal)

T. The resulting complex *eat*-PAST head would be spelled out as *ate*. With the explicit adoption of lexicalism in the Minimalist Program, articulated forms are inserted into the terminals and then their features are checked rather than acquired in movement or assignment processes.



The difference comes down to where properties like transitivity are located. In endoskeletal syntax with a traditional lexicon, the verb *ate* is still transitive by virtue of being indexed to a lexical entry with that property specified. This is true whether or not a particular instance of *ate* co-occurs with an internal argument. In exoskeletal approaches, transitivity is determined by structural context. Thus, the addition of an internal argument via an argument licensing head (call it AgrO) yields a transitive sentence.

(79)



Importantly, the addition of internal argument licensing heads is largely ungoverned. Lexical items do not determine the co-occurrence of other words or categories via selection, since by hypothesis they do not bear these properties; that is the provenance of the syntax. Therefore, an argument licensing head can in principle occur with any verb. This allows exoskeletal approaches to capture the flexibility of verbs to take

(or not) variable numbers of arguments, or verbal conversions or neologisms to take a number of arguments. Neither Borer's exoskeletal approach nor DM are committed to a specific internal argument licensing head.[4] This is unlike endoskeletal syntax, where internal arguments are licensed by specific heads (Baker 1988; Hale & Keyser 1993). Borer prefers to identify a projection of Aspect, AspP, as the head that provides case to internal arguments, but exoskeletal syntax by its very nature does not *require* that a particular head license particular kinds of arguments. In exoskeletal syntax, what matters is capacity, not identity. Any number of heads might have the capacity to license arguments, and they are at liberty to do so.

5.3.1 Application to Exotransitive Verbs

If prepositions are one of the functional heads capable of licensing arguments, then much progress has been made. It follows that both transitive and exotransitive verbs do not license their internal arguments. The inventory of heads that can license the internal argument is heterogenous; indeed, it is different between transitive and exotransitive verbs. What matters, though, is that this fact subverts the licensing problem. Simple transitive verbs do not license their internal arguments directly or on their own. Neither do exotransitive verbs. There is still the question of why overt Ps license the internal argument in exotransitives while null Ps do with transitives, and that issue will be returned to. For the moment, however, exotransitive and transitive verbs are no longer different on the dimension of licensing. Neither license their internal arguments. In the end, then, they are both just verbs, with no differences apparent at a lexical level.

Additionally, several problems are avoided by adopting an exoskeletal approach. Since exoskeletal lexicosyntax allows arguments to be introduced flexibly, there is no set inventory of internal argument licensing heads that would exclude P, making it impossible on theoretical grounds for P to be able to license an internal argument. Along similar lines, there are no possible violations of endocentricity, where P would be forced to lexicalize some head of among those that can license internal arguments like vP/TrP/AspP/AgrOP.

There are some outstanding questions. Are prepositions really functional heads in the sense of Distributed Morphology and the terminology of Borer (2005a; 2005b)? And what about the lexical entries laid out in Chapter 4? If an exoskeletal approach is adopted, such lexical representations are contentious, since in exoskeletal syntax, grammatical information is not present in the lexicon. Finally, there is the question of how the internal argument is linked to interpretation. In more rigid endoskeletal or constructionist

[4]It is worth noting that practitioners of Distributed Morphology disagree somewhat on this point. Harley (2008) states that internal arguments are licensed by the root, while Marantz (2005) argues that in at least some cases, a low applicative head (Pylkkänen 2002) is responsible. What is clear, however, and what is the only important point for the argument, is that argument introducing heads can be heterogenous in DM.

frameworks, there is a postulated absolute correspondence between structural position and thematic roles, such as Baker (1988)'s UTAH or the UAH in Relational Grammar (Perlmutter & Postal 1984). This removes the burden of thematic role assignment from the verb, and puts it onto structure. Each of these problems must be addressed. The first two will be dealt with in the following section, while the third will require a more extensive discussion.

5.3.2 Cleaning Up

5.3.2.1 Are Prepositions Functional?

Following on the reviewed literature Chapter 3, there have been frequent allegations in the literature that prepositions are "functional". What DM and Borer mean by functional are functional categories in syntax, which are those that realize grammatical content, such as morphosyntactic features (periphrastically or sometimes morphologically). And indeed, certain prepositional uses are compellingly functional - most notably pleonastic *of*. The characteristics of prepositions that most often lead them to be classified as functional are their apparent argument licensing properties and their grammatical necessity in constructions like passives.

But it is worth being wary of a broad generalization about prepositions, since many alleged prepositions lack these characteristics. In particular, there are the "complex prepositions", which have been distinguished from "simplex prepositions" predominantly in Germanic syntax (Zwarts 1997). The divide is more syntactically prominent in languages like Dutch and German, but it is evident in English as well. Compare the simplex prepositions (80) with the complex prepositions (81).

(80) a. She carried her dog *to* the truck.

b. Gus was standing *by* the bench.

c. The lizard was *on* the table.

(81) a. *According to* Jason, she carried her dog.

b. The game will be played *regardless of* the weather.

c. The spy made a run for it, *subsequent to* his discovery.

Complex prepositions are prepositions, but they fail to show the defining characteristics of functional categories. They are prepositions based largely on morphological and syntactic grounds. Consider the list of

complex prepositions compiled below. Complex prepositions are usually composed of some participle or relational term and a simplex preposition. In that way, they appear to be compounds of sorts.

(82) according to, except for, because of, aside from, prior to, outside of, owing to, due to, instead of, rather than, with regard to, in lieu of, in accordance with, in addition to

In addition, complex prepositions only rarely if ever specify a role, and they are not recruited by verbs to mark arguments. They fail to participate in pseudopassives or argument structure alternations.[5] Nor are they apparently ever selected, which implies that they are always adjuncts. Some also exhibit distinct syntactic irregularities as far as the class of prepositions is concerned. *Notwithstanding*, for example, is capable of being postpositional in American English.

(83) The rowdy couple next to us **notwithstanding**, we enjoyed our time at the restaurant.

Their general resistance to stranding is also notable. Thus, while simplex prepositions strand freely, complex prepositions do not.

(84) a. * What treat did she bring cookies instead of?

b. What party did she bring cookies to?

c. ?? What request did the engineer resign his post prior to?

d. What time did the engineer resign his post at?

Given their morphological, semantic, and syntactic differences, the distinction between complex and simplex prepositions is well-motivated. The position that simplex but not complex prepositions are functional is tenable and I adopt it for the remainder of this dissertation.

5.3.2.2 The Status of the Lexicon

Previously, I proposed along traditional lines that the lexicon contains articulated tuples of semantic, syntactic, and phonological information. The representations that I proposed for exotransitive verbs (one reproduced for reference below) do, however, contain such information.

(85)

[5] Or at least, no well-formed examples have ever been brought forth in the literature and I have been unable to think of any myself.

$$\begin{bmatrix} \textit{participate in} & \\ \textsc{copy-index} & \textcircled{1}\,\textcircled{2} \\ \text{participate} & \begin{bmatrix} \textsc{cat} & \text{verb} \\ \textsc{tense} & \text{pres} \\ \textsc{voice} & \text{active} \\ \textsc{mood} & \text{indicative} \\ \textsc{akt} & \text{atelic} \\ \textsc{index} & \textcircled{1} \end{bmatrix} \\ \text{in} & \begin{bmatrix} \textsc{cat} & \text{prep} \\ \textsc{subcat} & \langle \text{NP} \rangle \\ \theta & \textsc{Theme} \\ \textsc{case} & [\textsc{acc}] \\ \textsc{index} & \textcircled{2} \end{bmatrix} \end{bmatrix}$$

However, the lexicon is not composed of tuples of semantic, syntactic and phonological information in exoskeletal approaches, as noted. Lexical underspecification is not a peripheral issue. It is what allows structural context to determine properties like transitivity in exoskeletal syntax. How, then, can lexical underspecification be reconciled with (85)?

What I proposed was one way to state lexical dependencies within the typical conception of the lexicon in contemporary Minimalist syntax, in which lexical entries are atomic (Hornstein & Nunes 2013). By atomic here I mean just the sense of the smallest unit being an autonomous feature bundle. In order to make lexical dependencies comprehensible within this dominant and historic view, I represented the dependency as two feature distinct bundles that are linked in the lexicon. As I have said, I do not hold to any literal or even figurative containment between the constituent parts of an exotransitive, but the representation does force the two bundles to be operated on at the same time by the lexicon-syntax interface. In the interests of comprehensibility, I offered the formal definition of a possible operation, numeration copy, that would separate and distribute the linked feature bundles of an associated lexical entry into the numeration.

As was mentioned, there is no lexicon in exoskeletal syntax, at least not one that contained tuples of phonological, syntactic and semantic information. The lexicon instead consists of memory traces that link phonological representations to concepts, in whatever way that they are represented mentally. It is not possible therefore to think of (85) in terms of tuples containing grammatical information.

How can they be properly understood in in exoskeletal syntax? Grammatical properties are specified by other means (specifically, syntactic context), and so the only serious issue that confronts a translation of (85) into an exoskeletal framework is the issue of lexical dependency between verb and preposition. This issue

has been addressed by Borer (2005b). Writing of exotransitive verbs like depend on, Borer acknowledges the need for something like subcategorization. She calls exotransitive verbs "idioms", saying of them that they are "a partial representation of a phonological index with some functional value" (Borer 2005b: 354). What this means is that, at the level of representation that associates a concept with a phonological representation, there is also specified a particular "functional value" - in this case the obligatory realization of a specific preposition. Borer (2005b: 355) acknowledges that this move amounts to specifying lexical dependencies.

> The reader may object that subcategorization, of sorts, is introduced here through the back door, with the introduction, in lieu of lexical syntactic annotation, of an articulated listed structure...which accomplishes, *de facto*, the same task. The objection has of course some validity...

So even in exoskeletal syntax, there does appear to be a need for a way to specify lexical dependencies. One could easily adopt Borer's solution, which enriches the lexicon in exoskeletal syntax. If that approach is taken, (85) is the entry for the phonological representation of the verb which points to the preposition. The work here suggest perhaps a simpler approach. Take the specific example of gravitate to. As will be discussed in more detail in section 5.5.2, prepositions are associated with concepts that have to be realized along with verbs. The preposition to in gravitate to, for example, instantiates the concept of a point or centroid. It is no stretch to suppose that the concept of gravitate is linked mentally to the concept of a centroid, which is linked with the phonological representation of the preposition to. In that case, the representation (85) describes the corresponding phonological values for the linked concepts.

Given the similarities between DM and exoskeletal argument structure, the implementation in DM is not overly different, if lexical dependencies need to be stated. If they do, the implementation is nearly identical. Like exoskeletal syntax, lexical entires do not contain grammatical information in DM (Harley & Noyer 1999). The corollary to exoskeletal concepts are DM's concept of roots. Roots contain core lexical meanings and nothing else. A mechanism stating a the dependency between roots (perhaps linked at a conceptual level, as in exoskeletal syntax) would be necessary. On the other hand, there may be a solution particular to DM because of its commitment to determining phonological forms post-syntactically. In that case, it may be possible to have a single feature bundle for the meaning of depend on, with the only possible phonological spell out of that bundle being with the independent words depend and on.

Translations into yet more frameworks are possible. Primitive LFG lexical entries are atomic and contain more or less all the information about a word, including semantic and syntactic properties. The machinery that exists in LFG to handle multi-word expressions, called templates, are appended to phrase structure rules

and lexical entries (Asudeh et al. 2013). They count as an instruction to use a kind of structure which will be interpreted according to the template's semantics at the interface to interpretation, f-structure. Therefore, in LFG, an associative lexical entry for an exotransitive like (85) can be represented by a template for the construction, indexed inside each exotransitive verb, which requires the particular preposition that the verb takes. These could either be particularized instances of general templates (from which they inherit their shared properties) or be a general instance of a phrase structure that requires the preposition, along with literal selection of the preposition a la Bresnan (1982).

Finally, Construction grammar naturally handles associative lexical entries. In Construction grammar, exotransitive verbs would be associated with a common construction frame which would include the PP in the proper structural configuration, whatever that is figured to be in that framework. The only question is how to state the lexical dependencies, as acknowledged by Michaelis (2017) for the case of idioms and other multi-word expressions. The solution is to define a "head" of the idiom, with the first word of the idiom being the most plausible candidate, and then state each of the lexical dependencies within the head of the idiom. This solution resembles l-selection (of either the LFG or Minimalist variety), but it also includes structural information.

5.4 Linking to Interpretation with Full Thematic Separation

The third problem raised at the conclusion of Section 5.2 was how the internal argument is linked to interpretation. By interpretation, I am referring to the correspondence between arguments in the syntax and their role interpretation in the semantics. The linking problem exists for both transitive and exotransitive verbs. In endoskeletal syntax especially, although it is also conceivable in exoskeletal syntax, the thematic role of an argument is often associated with a particular position[6]. The particular position is identified in various ways, but it is almost always identified with the canonical object position (the complement of the verb). Since the object of a preposition is not a canonical object position, it is incapable of yielding the correct interpretation of its object as the internal argument. Consequently, transitives would have the correct thematic interpretation of their internal arguments, while exotransitives would not.

Therefore, another approach is needed, one which does not posit a correspondence between positions and thematic roles. Full thematic separation is one such approach to semantics and the syntax-lexicon interface (Castañeda 1967; Parsons 1990; Schein 1993). It is characterized by its commitment to representations

[6]Whether by assignment under government as in GB, or by the aforementioned UTAH/UAH or constructionist approach of Hale & Keyser (1993).

where argument NPs are not taken at any point by verbs, but are instead taken by thematic predicates. Full thematic separation shares a number of important assumptions with exoskeletal approaches, making them a natural fit, although as mentioned they do not necessarily need to be paired. Among the shared assumptions is that lexical items do not take arguments, and frequently also there is at least a tacit commitment to UTAH or a related position.

In full thematic separation, arguments in the syntax are introduced by thematic predicates in the semantics. A thematic predicate is a predicate which binds the event variable and the requisite nominal. Thematic predicates correspond to thematic roles; so there is a AG for the Agent role, TH for Theme role and so on. Consider the example (86).

(86) Brandon hit Joe.

The agent (*Brandon*) and the theme (*Joe*) are identified in the semantics by thematic predicates, whose denotation is given in (88a-b). Identification is achieved by an evaluation function ($[\![\cdot]\!]$). This evaluation function operates over the terminal nodes to yield their semantics, and the LF structure serves to identify and order the semantic operations that result in sentence interpretation. Thus, for sentence (87), which includes postulated silent lexical items that evaluate to thematic predicates, the resultant semantic representation is (88c).

(87) [AG Brandon] [hit [TH Joe.]

(88) a. $[\![\text{AG}]\!] \simeq \lambda x \lambda e[\text{Agent}(e, x)]$

b. $[\![\text{TH}]\!] \simeq \lambda x \lambda e[\text{Theme}(e, x)]$

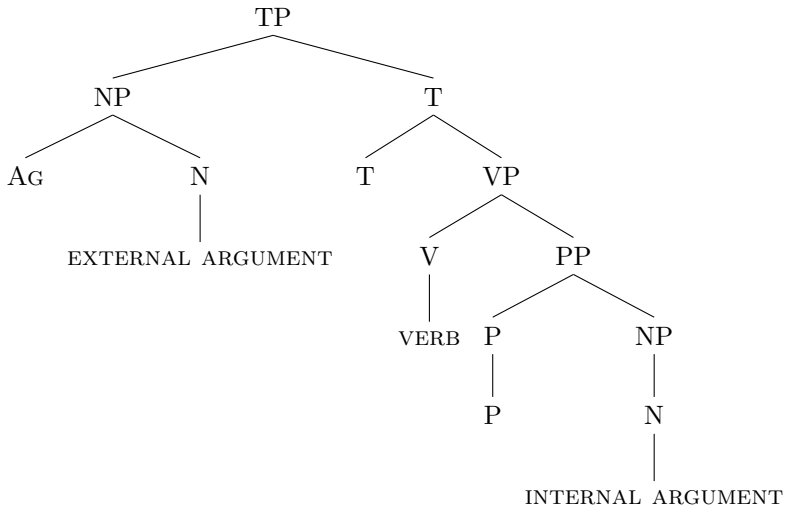
c. $\exists e[\text{hit}(e) \wedge \text{Agent}(e, \text{Brandon}) \wedge \text{Theme}(e, \text{Joe})]$

In (86), the thematic predicates AG and TH are present, and they take their corresponding nominals as their complements. By virtue of (88a-b), they take their nominal in the semantics. In the next section, I will outline how full thematic separation links the internal argument to its thematic interpretation such that both simple transitive and exotransitive verbs work identically.

5.4.1 Applying Full Thematic Separation to Exo/transitive Verbs

Recall the generalized transitive structure discussed in the introduction. It is updated here as (89) to include exoskeletal argument structure, thematic heads, and more prototypically Minimalist clause structure.

(89)



By adding the insights of full thematic separation, the generalized structure (89) can yield the appropriate semantic representation. For convenience, I will go forward adopting the position that specific heads identify arguments at the syntax-semantics interface. The lynchpin of the analysis is to postulate that functional prepositions evaluate to thematic predicates. So, on the one hand, there are particular $P_{\emptyset}$s that evaluate to particular thematic roles (90). On the other hand, there are also particular prepositions that evaluate to particular thematic roles (91). There is overlap between these, such that for a given thematic predicate, there might be both an $P_{\emptyset}$ that evaluates to it and also an overt P.

(90) a. $[\![P_{ag}]\!] \simeq \lambda x \lambda e[\text{Agent(e, x)}]$

b. $[\![P_{th}]\!] \simeq \lambda x \lambda e[\text{Theme(e, x)}]$

c. $[\![P_{instr}]\!] \simeq \lambda x \lambda e[\text{Instrument(e, x)}]$

d. $[\![P_{src}]\!] \simeq \lambda x \lambda e[\text{Source(e, x)}]$

e. ...

(91) a. $[\![\text{by}]\!] \simeq \lambda x \lambda e[\text{Agent(e, x)}]$

b. $[\![\text{on}]\!] \simeq \lambda x \lambda e[\text{Theme(e, x)}]$

c. $[\![\text{with}]\!] \simeq \lambda x \lambda e[\text{Instrument(e, x)}]$

d. $[\![\text{from}]\!] \simeq \lambda x \lambda e[\text{Source(e, x)}]$

e. ...

(91) is reminiscent of Fillmore's work surveyed in Chapter 3, and to some extent also the preposition-case equivalence more generally. The principle difference is that this is not an equivalence between prepositions

and cases, but a correspondence in the syntax-semantics interface between prepositions and thematic roles. Functional prepositions are not literally these thematic roles, but they can be interpreted in that way. These meaning postulates make sense of the behavior and expression of a number of DO/PP alternating verbs. Consider (92). The verb *escape* in (92a) takes a source internal argument, and this argument can also be taken by the source preposition *from*. The same goes for the instrument and theme internal arguments in (92b-c). There are few detectable differences between the prepositional and DO expressions, despite the fact that their exponence is on the surface very different.

(92) a. Nick escaped (from) Alcatraz.

b. Some solider shot (with) the rifle.

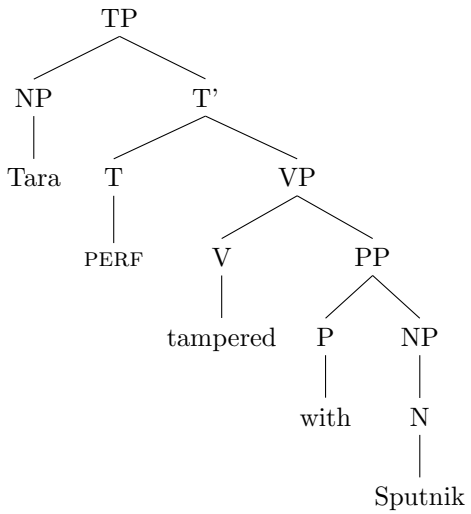
c. The passenger chewed (on) her gum.

The data in (92) make sense given (90-91). Full thematic separation and exoskeletal syntax permit both prepositional heads (both overt and null) to introduce the argument. Since the structures are the same and they are linked to interpretation in the same way, there are no apparent meaning differences.

Given (90) and (91), the direct object in the generalized structure (156) will evaluate to the argument of a thematic predicate. Consider the (simplified) example of the exotransitive verb *tamper*, given in (93).

(93) a. Tara tampered with Sputnik.

b.



Following on from the discussion of exoskeletal syntax and the generalized transitive structure, a lexical item which is not the verb takes the internal argument, namely *with*. There is no way that *Sputnik* is ever

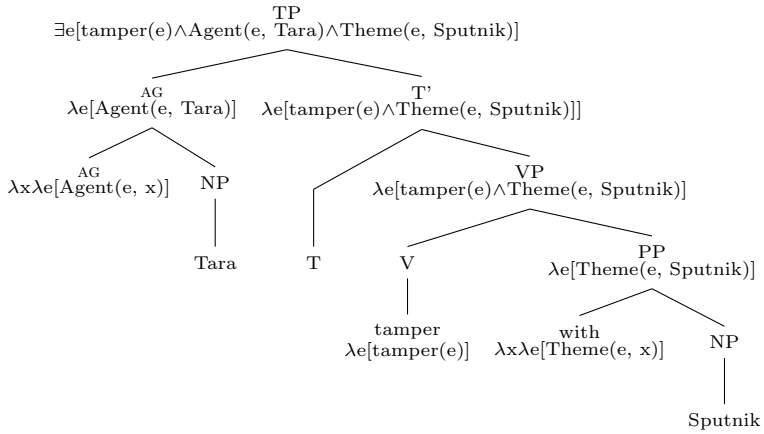
the object of *tamper* syntactically; instead, it originates as and remains the object of *with*. (93) will be output to LF retaining that critical relationship. As a consequence, the internal argument *Sputnik* cannot be introduced into the semantics as an argument of *tamper*. Instead, it will be introduced as the argument of the preposition.

(94) a. $[\![\text{tamper}]\!] \simeq \lambda e[\text{tamper}(e)]$

b. $[\![\text{with}]\!] \simeq \lambda x \lambda e[\text{Theme}(e, x)]$

The semantic derivation of (93a), then, is (95). I do not assume that Voice introduces the external argument, *a la* Kratzer (1996), but rather that it is introduced by a separate AG. I will also ignore the role of tense in (95).

(95)



In the final counting, then, exotransitives and transitives have the same syntactic structure in a general sense. Their arguments are linked to interpretation in the same way: via the intermediate head P which introduces the argument into the semantics and evaluates to a thematic predicate. Together, this solves the licensing problem in full. Nevertheless, there is still a significant issue that hasn't been addressed. Namely, why do exotransitives make use of an overt preposition, and not a thematically equivalent $P_\emptyset$? Syntactically speaking, there is no apparent reason. Both overt prepositions and their $P_\emptyset$ equivalents in theory have the same structural relation to verb and preposition and evaluate to the same possible set of thematic predicates. Therefore, a syntactic requirement does not seem an overly promising direction. In the next section, this question is taken up from a different angle.

5.5 Where the Preposition Comes From

The conjunction of an exoskeletal model of syntax and full thematic separation solves many problems of unifying exotransitivity with transitivity. In so doing, however, it asks the new one introduced above, namely, why do exotransitive verbs make use of prepositions? This question is particularly poignant for the approach I have adopted because that approach is purposefully flexible. There are no *a priori* restrictions on what heads might introduce arguments. Consequently, while exotransitivity is a possible expression of transitivity, there seems to be no reason why examples like (96) would not be well-formed given the meaning postulates in (90-91).

(96) a. * [John [depends [P_{th} [Mary]]

b. * [[By_{ag} [her]] [sleeps]]

c. * [[The sentries] [vacated [$from_{src}$ [the watchtowers]]]]

There is no regulatory framework within exoskeletal syntax or full thematic separation to prevent (96). The necessity of prepositional exponence in exotransitives must therefore arise for other reasons. In this section, I will argue that there are at least two causes that give rise to necessarily exotransitive verbs (rather than alternating verbs). These causes have similar motivations, but different mechanisms. The first cause is morphosyntactic: the preposition realizes some necessary morphosyntactic feature periphrastically with the verb. The second cause is semantic: the preposition realizes a semantic property derivative from the lexical item. I will discuss these in turn, followed by a brief discussion of some cases that remain opaque.

5.5.1 Exotransitive Prepositions as Periphrastic Realizations

A positive case can be made that prepositions realize morphosyntactic features in combination with exotransitive verbs. Effectively, this capacity makes them inflectionally periphrastic, *a la* periphrastic tense expressions familiar in the English verbal system. To be explicit, I am proposing that certain exotransitive verbs are that way because they necessarily must occur in the local context of a morphosyntactic feature borne by the preposition. As an analogy, consider the case of the future perfect below.

(97) They *will have retrieved* the marbles before noon.

The future perfect requires two auxiliaries, the future of *be* and the perfect of *have*, in concert, to realize the future perfect tense. Like exotransitives, these are syntactically distinct words. (98) shows them separated by adverbs.

(98) They will (easily) have (easily) retrieved the marbles before noon.

Like exotransitives, they are also arranged hierarchically. Elliptical processes can delete variable parts of the collocation.

(99) a. Sharon's team will have retrieved the marbles before noon, and Jessie's team will have before the evening.

b. Sharon's team will have retrieved the marbles before noon, and Jessie's team will too.

Exotransitives therefore share two important properties with periphrastic constructions which provide clues as to the purpose of the preposition. First, they realize morphosyntactic features, as I argue below, and second, they are composed of separate words. These facts together explain why exotransitives of this kind must have a preposition. In the same way that there is no synthetic realization (for whatever reason) of the future perfect tense in English, there is no synthetic realization of an exotransitive. The only possible morphological realization of the meaning expressed by an exotransitive like *consist of*, for example, is with the verb and the meaning realized by the preposition. There is no affixal equivalent of *of*, and there is no thematic $P_{\emptyset}$ head such that $P_{\emptyset}$ *also* realizes the meaning that *of* realizes, since $P_{\emptyset}$s are semantically null by hypothesis (outside of their thematic content). Consequently, the only possible exponence of *consist*'s object is prepositional. Below, I survey three cases of the morphosyntactic meanings borne by prepositions: path, affectedness, and directness of experience.

5.5.1.1 Path Realization

Direct motion is specified on motions verbs by prepositions. In (100a), the manner motion verb *hike* has no specified path, but a path can be supplied by a nominal argument (100b).

(100) a. Holly hiked.

b. Holly hiked the Appalachian trail.

In (100b), *Holly* has hiked the entirety of *the Appalachian trail*, such that *the Appalachian trail* specifies the path and bounds the event of hiking. Argument prepositions can be added which take the same noun in the same kind of role. As evidence that the ability to delimit the event is related to the specific lexical content of the preposition and not just the structural appearance of a preposition, consider the examples in (101). One of these (101a) adds a path, with similar meaning to (100b), while (101b) does not add a particular path. Instead, in (101b), *the Appalachian trail* does not delimit the path taken in the hiking event. It could

be that the hiking event took place parallel to *the Appalachian trail*, so it is not the path. The same is not true of (100b) or (101a), where the hiking event must take place on *the Appalachian trail*.

(101) a. Holly hiked up the Appalachian trail.

b. Holly hiked along the Appalachian trail.

It is therefore some particular semantic or morphosyntactic feature borne by the preposition that causes the event to be delimited or not. [7] The noun itself seems impotent to do this, as any particular noun will receive the same path interpretation. And yet, those nouns, when taken by the proper preposition, may or may not have path interpretations. Since nouns do not change path properties while prepositions do, the preposition is realizing a path property, which bounds the extent of the motion.

5.5.1.2 Affectedness Realization

Prepositions also realize affectedness distinctions. As noted by Borer (2005b), verbs like *kick* do not need an internal argument, although when they take one the theme is affected (102).

(102) a. The baby kicked.

b. The baby kicked the ball.

The affectedness of the theme can be modulated by the presence of prepositions. In (103a), *the ball* is not affected, in the same way as nothing is affected by the action of the verb in (102a). In (103b), *the ball* is affected as it is in (102b), although to a lesser extent.

(103) a. The baby kicked at the ball.

b. The baby kicked into the ball.

The preposition is realizing different extents of affectedness in (103). Any noun in place of *the ball* in (102b) will be affected, while any noun in a similar place as *the ball* in (103) will be affected or not affected corresponding to the preposition. What this argues is that it is prepositions which determine affectedness, and not necessarily the verb.

[7] It might seem that some property of the noun might contribute a bounded path reading, so that no P needs to carry out this function, but this is mistaken for two reasons. First, the noun itself ostensibly does not have this function, since its combination with a preposition like *along* does not bring about a path reading as discussed (and so it is again the preposition that is determining whether there is a path or no path). Second, nouns which do not come associated with any particular path still get a path-like interpretation, thus *Holly hiked the cornfields of Iowa* means that there was an event of hiking where the entirety of the cornfields of Iowa were hiked through. In more common terms, a path-less noun like *the cornfields of Iowa* is *coerced* into having a path interpretation.

5.5.1.3 Directness of Experience Realization

A final category of interest is directness of experience. It manifests in certain verbs like *read*. So, in (104b), *Tom* has direct experience of *the Vedas*.

(104) a. Tom read.

b. Tom read the Vedas.

Prepositions can modulate the directness of experience that *Tom* has with *the Vedas*. Consider the function of *of*, where *Tom* has no direct experience, and (105b) where he does, in (105a).

(105) a. Tom read of the Vedas.

b. Tom read through the Vedas.

So again, prepositions are the ones that cause systematic changes in interpretation. The direct experience interpretation of a nominal argument with verbs like *read*, by inference, comes about through a mediating preposition which realizes the directness of experience.

5.5.1.4 Prepositional Realization

Along the three dimensions discussed, prepositions can determine some property that changes the relationship of the event to the verb's argument. Whether or not the interpretation changes has to do with the morphosyntactic or semantic feature(s) that the preposition bears and realizes for the verb.

The cases I presented above in (100-104) suggested the presence of a null preposition alternating with visible prepositions which differed systematically by some property. In some cases, like (102-103), the differences were a matter of degree ($\emptyset$ > *into* > *at*, in terms of how affected the object is). A continuum where prepositions realize different points on the scale of some property like evidentiality or affectedness, suggests a paradigmatic organization of prepositions along these dimensions. I mean paradigmatic here in a manner similar to the paradigmatic organization of inflectional categories. Compare a paradigm like degree of comparison with adjectives to "degree of affectedness" with prepositions.

Degree	Realization	Example
Positive	$\emptyset$	wet
Comparative	*-er*	wetter
Superlative	*-est*	wettest

Degree	Realization	Example
Unaffected	*at*	kick at the ball
Mildly Affected	*into*	kick into the ball
Fully Affected	$\emptyset$	kick the ball

Analogous to morphological paradigms, the presence of a preposition realizes some morphosyntactic feature periphrastically with the verb. A null expression ($P_\emptyset$) is part of the paradigm. The absence of an

overt preposition comes with the unmarked meaning along the inflectional cline. As discussed, whatever the preposition realizes, the prepositional exponent is necessary for realizing it. Therefore, exotransitive verbs can be thought of as obligatorily periphrastic transitive verbs; for whatever reason, they do not bear the morphosyntactic features that the prepositions carry for them, meaning that when the verb occurs, the preposition must also.

5.5.2 Exotransitive Prepositions as Lexical Semantic Realizations

Not all verbs and especially exotransitives are like *kick* in having their preposition realize a morphosyntactic feature, however. As has been pointed out periodically, some combinations are compositionally opaque, and the preposition does not appear to be adding any morphosyntactic information to the interpretation. An especially stark case is with exotransitives that make use of the preposition *of*, a preposition long rumored to be without semantic content (Chomsky 1970). The question can be stated with clarity by using *of* as an example: what exactly is the contribution of *of* in exotransitives like *divest of* or *smack of*?

Interestingly, the occurrence of *of* might be one of the easier cases to explain. The preposition *of* actually occurs with a range of semantically similar verbs. *Divest of* is similar to *denude of* and *dispose of*. Other cases that break across preposition types are *bereave of*, obligatory *dispossess of*, obligatory *deprive of*, alternating *relieve of* and obligatory *rid of*. All of these verbs have in common the meaning that something possessed or in some way attached to the subject is being removed and is consequently no longer in possession of the subject. This common meaning provides a tantalizing possible explanation. The preposition *of* is well-known for its use in possessive constructions like (106) below, where it can often alternate with the genitive clitic *-s*.

(106) a. The moustache of the general

b. The general's moustache

c. The car of her mother

d. Her mother's car

All the verbs mentioned above (*divest, denude, dispose, bereave, dispossess, deprive, relieve, rid*) indicate a change in possession, just as *of* in the nominal cases (106) indicate the possession of the NP. It is no great leap to suppose that *of* is occurring with verbs for the same reason and in the same capacity that it does with nouns: it is signaling possession. The different verbs all are specifying slightly different manners of

the change in possession, the same way that *stroll* and *saunter* both indicate a walking motion, but specify different ways that it is happening.

So, while *of* does not appear to be signaling possession in the same way with verbs as with nouns (with nouns, it signals possession by the head NP, with verbs, the whole expression signals a change of possession away from the subject), the possessive meaning links the nominal and verbal uses of *of*. This explanation is undoubtedly on the right track. However, implementing it is another matter. The problem, simply put, is that possession is not a verbal property or a morphosyntactic feature, but rather a relation between two NPs. As such, a periphrastic treatment described in Section 5.1 will not work. Instead, another avenue for implementing this intuition is necessary.

Instead of the preposition realizing a morphosyntactic feature in the *of* cases, they appear to be fulfilling something conceptually required by the verb. The prepositions therefore occur because they must realize some argument due to the verb's lexical semantics. What aspect of the verb's lexical semantics is at play? All theories of lexical semantics include an irreducible or otherwise undefinable component of meaning, which is typically represented by the word itself. Take the exotransitive *gravitate* as an example. *Gravitate* is an atelic motion verb derived from *gravity* with the informal meaning of "to move or be attracted by means of gravity". Consider the meaning postulate for *gravitate* in (107) below.

(107) gravitate $\simeq \lambda x \lambda e[\ \mathrm{GO}(e,x) \wedge \mathrm{ByMeansOf}(e,$ *gravity*$)\ ]$

The postulate (107) is not actually atomic, however. The meaning component of *gravity* can be broken down further, as shown in (108) where gravity is defined as a centroid that exerts an attracting force.

(108) gravity $\simeq \lambda y[\ \mathrm{endpoint}(y) \wedge \mathrm{centroid}(y) \wedge \mathrm{exerts}(y,$ *attracting-force*$)\ ]$

The meaning postulate for gravity above says that gravity is an attracting force directed toward a centroid. The idiosyncractic portion of meaning is the notion of an attracting force, which cannot be broken down further. Now the meaning postulate for *gravity* can be substituted into the meaning postulate for *gravitate*, yielding the full definition below.

(109) gravitate $\simeq \lambda x \lambda e[\mathrm{go}(e,x) \wedge \lambda y[\mathrm{centroid}(y) \wedge \mathrm{endpoint}(y) \wedge \mathrm{exert}(y,$ *attracting-force*$)\ ]\ ]$

By combining the postulates for *gravitate* which contains the one for *gravity*, the meaning postulate for *gravitate* says that to *gravitate* is to move by means of a centroid that exerts an attracting force. This is an adequate definition of *gravitate*, but there is a problem. What is notably *not* contained in the meaning postulate (109) is any notion of the PP headed by *to*, and its object. What can be said about *to*, then? How

does it relate to (109)? Begin by considering what the meaning of *to* is, at least in the locative contexts. *To* denotes an endpoint centroid in many contexts in which it occurs. In other words, *to* denotes an endpoint of motion or action which is the center of a larger mass or area. These can be expressed with the meaning postulate given below.

(110) to $\simeq \lambda$x[centroid(x) $\wedge$ endpoint(x)]

The preposition *to* comes about in *gravitate to* because the definition of *gravity ipso facto* requires a centroid. This will require the realization of the preposition *to*, because there is a second lambda operator inside the event closure. In effect, what this is saying is that the larger word *gravitate* contains something within it that has structure but which is not given an interpretation by *gravitate*. Or, a simpler way of saying it is this: (109) says that given an event and an *x*, gravitating relates them by saying that *x* went, and there it stops. But, as I have been arguing, this halt is insufficient to render a well-formed verbal expression with *gravitate*, because the endpoint and centroid are left unspecified.

The reasoning behind this answer is more easily grasped by comparing *gravitate* to the verb *steam*, in the sense of motion by means of, like *The ironclad steamed out of the harbor.* Like *gravitate*, *steam* is a motion verb whose root specifies the source of the force that is propelling the motion. Its representation in a sentence like (111) would be something like (112).

(111) The ironclad steamed down the Mississippi river towards New Orleans.

(112) steam $\simeq \lambda$xλeλy[go(e,x) $\wedge$ ByMeansOf(e, *steam*)]

In many respects, (112) resembles (107). Crucially, however, the meaning of *steam* is quite different from the meaning of *gravity*. Whereas *gravity* is a force that induces motion, composed of a centroid and an endpoint, *steam* has no such associations. Steam is used to push a turbine, which is what does work; there is no meaning component at all analogous to a gravitational centroid or endpoint. As a result, there is no portion to substitute into (112) which might call for an additional argument. And hence, they are different with respect to the necessity of prepositional dependents or additional arguments.

The *gravitate*/*steam* illustration shows why one verb and not another might need an additional argument that it cannot take with a generic null preposition. It comes down to the unanalyzable component of their semantics, and whether it carries with it some possibility or need for another argument. That perhaps explains *why* another argument might be needed, but it does not explain *how*. The key is the split of the postulate into two components, one for the verbal meaning and the other for the unanalyzable component.

While unconventional, this move appears to be necessary. Only together do the verb and preposition actually yield the meaning of (109); without the preposition, there is no specification for the centroid exerting the attracting force, and without the verb there is no motion. The conjunction in the definition is a convenient way of separating the parts so that they can be built separately before combining. Thus, in the syntax (and so before the semantics), *gravitate* enters the derivation as:

(113) gravitate $\simeq \lambda x \lambda e[\text{go(e,x)} \wedge \lambda y \lambda P \lambda Q \lambda R[\text{P(y)} \wedge \text{Q(y, } \textit{attracting-force}\text{)} \wedge \text{R(y)}]]$

Meanwhile, the second conjunct is fully specified for these properties, and given the relationship between *gravitate* and its associated preposition, it will always retain the appropriate interpretation.

(114) to $\simeq \lambda y[\text{centroid(y)} \wedge \text{exert(y, } \textit{attracting-force}\text{)} \wedge \text{endpoint(y)}]$

So, in the case of a verb like *gravitate*, the meaning is complex, with the preposition required by the lexical semantics of the verb. In the case of the verbs that take the preposition *of*, the idea of *possession* is the portion that requires *of* rather than a null thematic head. Sometimes the meaning can be discovered easily, like *of*, according to the groupings of semantically similar verbs. Other times, however, there are no groups to assist in identification. In that case, in-depth consideration of the verb is required to identify what the preposition is doing.

Below I have given a description of various exotransitive verbs and their accompanying prepositions along the lines of the preceding analysis. I have not endeavored to do an analysis like this for every relevant exotransitive, but a sufficient number are documented as an example.

(115) a. on $\simeq \lambda x \lambda y[$ supports(x, y) $\wedge$ bounded-plane(x) $]$

b. in $\simeq \lambda x \lambda y[$ contains(x, y) $\wedge$ bounded-plane(x) $]$

c. with $\simeq \lambda x \lambda y[$ be.together(x,y) $]$[8]

d. to $\simeq \lambda x[$ centroid(x) $\wedge$ endpoint(x) $]$

e. from $\simeq \lambda x[$ centroid(x) $\wedge$ origin(x) $]$

f. of $\simeq \lambda x \lambda y[$ possess(x, y) $]$

In Appendix F, I have provided some notional groupings of exotransitive verbs (and sometimes alternating/obligatory verbs where especially relevant). Accompanying each group, the table provides a description according to the components of the preceding analysis of opaque exotransitives.

[8] A wide definition of *with* is being used here. Comitative and instrumental readings at first seem quite different, but common to them is the idea that the head noun and the complement of *with* are acting together in some way. There is room for both elaboration and clarification in this case (and others) but since my purpose is to provide a proof of concept rather than a detailed analysis, I will not go in depth about the most appropriate representation of *with*.

5.6 Summary

This chapter began with a discussion of the licensing problem. The primary issue was how exotransitives and transitives, pursuant to the arguments in preceding chapters that they are the same, license their internal arguments in the same way. I argued that by adopting an exoskeletal syntax and positing a mediating null preposition in simple transitives, their structures are identical. They are linked to interpretation by adopting full thematic separation, in which both null and overt prepositions evaluate to thematic predicates in the semantics. These moves resolved the licensing problem, but opened up the question of why the preposition must occur in exotransitives, since these frameworks eschew selection or an elaborated lexicon. The final sections were devoted to explaining within these frameworks how and why the preposition occurs. In some cases, the preposition realizes morphosyntactic features. In others, a portion of the verb's lexical semantics requires the preposition to be realized.

CHAPTER 6

Prepositions as Transitivizers

6.1 Introduction

The previous chapter demonstrated that the content of prepositions are significant in combination with verbs. The necessity of this content ensures the occurrence of the preposition, and thereby ensures the occurrence of an internal argument. But the nature of the content of the preposition varies by exotransitive verb. Some prepositions occur with exotransitives because they realize very general meanings like source in *emanate from*, while others are highly idiomatic and are difficult to pinpoint like in *rely on*.

From a theoretical standpoint, this heterogeneity is unsettling. On its face, it suggests that there is no particular reason why *prepositions* should participate in exotransitives or play any particular role of importance in determining verbal valence over and above any other category that might realize the same meaning. So assuming in this speculative example that *with* in *interfere with* is marking an instrument, there should be little reason why **interfere using* would be ill-formed. Instead, however, there does appear to be something particularly about prepositions which results in their use for marking internal arguments in exotransitives.

What is to be made of the uniquely prepositional nature of expressing additional arguments in English[1]? On the one hand, it must have something to do with their syntactic ability to take arguments in the first place, but on the other, non-finite verbs also have that ability. At the same time, they do not make the same semantic contribution in every case when they do take arguments for verbs. So in the final counting, it seems that there is nothing particularly unique about prepositions as a class that should cause them to be used in exotransitives to take the internal arguments. And if that is the case, then the systematic use of prepositions is just accidental; they just happen to have both the semantics and the argument taking ability, and so they are employed. Should a member of any other category have the requisite properties, it would be equally possible.

While it is a possibility that the association of prepositions and valence is accidental, it is not a particularly

[1]With the notable and contentious exception of double object constructions.

satisfying answer. What is more, it does not seem to be quite right, either. For one, there are poignant examples of prepositions participating in the valence system. Agentive phrases in passives systematically use the preposition *by*. Objects of prepositions can be passivized in English, yielding pseudopassives. When considered in light of exotransitive/alternating/obligatory verbs, these examples argue that prepositions are systematically employed to mark arguments in conjunction with verbs and under specific grammatical conditions.

While the particular reason why prepositions are used to mark arguments may for the moment remain inscrutable, it is possible to demonstrate empirically that there is an association between prepositions as a category and the valence system of English. So, while it may not be clear what is common to prepositions that causes them to be used to mark arguments, it will be clear that there is something about the nature of prepositions specifically which causes them to be used in that way. In this chapter, I present the results of an artificial language learning experiment on prepositions and valence. The results argue that prepositions are associated intrinsically with argument licensing for verbs.

6.2 An Experimental Approach to Verbs and Transitivity

The goal of the forthcoming experiments is to uncover learners' preferential association between prepositions and transitive events. If learners associate prepositions with transitive events, then this supports the idea that prepositions are related to the mechanisms of valence. A bias for prepositions to mark transitive events would constitute good evidence that prepositions and transitivity are related.

One way to see what biases speakers have about language is to expose them to inconsistency in an artificial language learning task. Inconsistent input reveals the inductive biases that speakers bring to the task (Kirby 2001; Reali & Griffiths 2009; Culberston, Smolensky & Legendre 2012). Learners in an artificial language task make inferences about the input according to properties of the input (particularly frequency) as well as their biases. The effect of the biases are manifest in a subsequent generalization task.

Work in artificial language learning shows that learner's biases can play a prominent role. Of particular interest are cases where learners behave in a way that is not evident or consistent from the input frequencies. Lidz, Gleitman and Gleitman (2003) showed that learners used a statistically less informative structural cue over a statistically more informative morphological cue. They argued that this showed that learners have an inductive bias to prefer certain kinds of cues (in this case, structural ones) in spite of the informativity of the statistics. Other work in artificial language learning has confirmed the importance of learner's biases.

Moreton (2008) demonstrated asymmetric performance from identical statistics in the learning of phono-

logical constraints. He exposed learners to dependencies between segments on the dimensions of vowel height, obstruent voicing, and then an unnatural dependency between height for one segment and obstruent voicing for another. Learners were successful at learning the dependency between height relations and the dependency between voicing relations, but they were not successful at learning dependencies between height and voicing. Such results are powerful demonstrations that while the input statistics are surely learned, not everything is equally learnable.

Schumacher and Pierrehumbert (submitted) showed that, while variable, many learners show a preference for certain kinds of marking systems. They exposed learners to two types of number marking system, the English-like Plural, and the Welsh-like Singulative. Learners who saw Plural with a strong frequency advantage produced more Plural. By contrast, a significant number of learners who saw Singulative with a strong frequency preference produced more Plural than was seen in the input. They hypothesized that these learners were enforcing a bias for the Plural on the input, even when it was in conflict with the input frequencies. There have been other results where significant biases have been observed; for example, in an experiment on word order patterns, Culbertson, Smolensky and Legendre (2012) learners generalized word order patterns that were consistent dominant typological patterns.

Given its ability to expose learner's biases, artificial language learning can be used to establish the operation of a bias to use prepositions as part of the valence system. In particular, the existence of asymmetric generalization would establish the existence of such a bias. That is, if learners with access to the same statistics in the input generalize prepositions to a transitive function more than they do to an intransitive function, this argues for the existence of a bias to associate prepositions with transitivity. In what follows, I describe two experiments which together demonstrate the existence of that bias, and therefore a cognitive bias to associate prepositions with valence.

6.3 Experiment 1: Valence-Increasing Morphology

6.3.1 Motivation

The purpose of this experiment is to assess how much transitivizing morphology is generalized. This will serve as a good comparison for the manipulation in the second experiment, prepositional enclisis. The purpose of testing the extent of generalization with prepositional enclisis is that it measures the affinity that prepositions specifically have with transitivity. The effect of prepositions particularly is best evaluated with respect to a baseline, however, since it is plausible that any morphological change whatsoever would

be recruited preferentially to mark transitive distinctions. The comparison to prepositional enclisis, then, demonstrates the strength of association between prepositions and transitivity, rather than the the strength of association between any morphosyntactic change and transitivity.

There is every reason to suspect that a morphosyntactic change will be associated with either a valence-increasing or a valence decreasing function. Morphologically cued valence operations are common cross-linguistically. Bybee (1985) states that valence is the most commonly morphological property manifest on verbs, exceeding even tense and person marking. She reports that 90% of that languages she sampled had some kind of valence marking on the verb. Specifically valence-increasing affixes appear to be particularly common. In the WALS (Dryer & Haspelmath 2013), nearly 90% of languages surveyed had morphological marking for causatives, a kind of valence-increasing morpheme. However, the more important comparison is the contrast between valence-increasing affixation/valence-decreasing affixation (and the corresponding contrast with enclisis). Since valence is commonly marked on the verb, both valence-increasing and valence-decreasing kinds, the experiment will expose which of these categories is more salient.

6.3.2 Design

6.3.2.1 Participants

450 participants were recruited over Amazon Mechanical Turk. They were paid $3 for their participation.

6.3.2.2 Materials

6.3.2.2.1 Artificial Language

The artificial language was composed of six verbs, six prepositions, and thirteen objects. The table below gives detailed information about the words. The meanings and the word forms are presented in no particular order. Except for the object “Sigi”, which was always the subject of each sentence and always corresponded to the “bug”, these were randomly assigned for each participant.

Word Type	Orthographic Profile	Word Forms	English Meaning
Verbs	CVCVCV	tutile	spiral
		bobili	teleport
		sepino	bounce
		romina	zigzag
	CVCCVV	ponrea	cross
		fenrie	leap
Prepositions	CVC	dir	above
		cit	on
		tis	beside
		sil	in front of
	CVV	pio	under
		nai	below
Objects (Nouns)	CVVC	ceir	bear
		siol	food
		veon	pitcher
		roos	strange hat
		biet	strange fruit
	CVCV	dite	fox
		wodi	human
		nepa	gourd
		hasa	candle
		sigi	bug
		nive	flower
	CCVV	slee	banana
	VVCC	erit	mushroom
Affix	-CCVC	-ffek	valence change

Subject-Verb-Preposition-Object was the basic word order. The form of the affix was -CCVC. An example sentence with the affix and without is given below.

(116) Sigi romina tis wodi.

(117) Sigi rominaffek tis wodi.

There were 36 unique combinations of verbs and prepositions. Each reference object occurred with each verb three times and each preposition three times.

6.3.2.2.2 The Actions

"Sigi" performed six different actions corresponding to one of each of the verbs. The actions could be performed at every spatial orientation denoted by the preposition, and did not differ depending on the

preposition, except in extent. For example, the action looked identical whether "Sigi" was above (at the top of the screen) or below (at the bottom of the screen). But when the preposition was the one corresponding to the meaning of "beside", the action was performed beside the reference object, which was a shorter length than other orientations. The actions performed by "Sigi" were therefore good representations of the preposition in conjunction with the verb. The actions and spatial orientations are separable. In that sense, these actions are intransitive: the action is all done by "Sigi", and the object is used as a reference point for the meaning of the preposition.

Each one of the actions that could be performed could also be performed in a way that involved the reference object. In every case, "Sigi" would start the action first, followed by the reference object performing the same action. The action would occur at the horizontal intersection of the location of the reference object and "Sigi". Consequently, the period for which the reference object was performing the action was always shorter than the period that "Sigi" was. Consequently, "Sigi" initiates the action, and has some kind of contact with the reference object, after which it also moves. This kind of an event is interpretable as a causative event (Bunger p.c), which is inherently valence-increasing. Every preposition-verb pair occurred twice, once as an intransitive and once as a transitive (causative) event, for a total of 72 trials based on the vocabulary and actions.

6.3.2.2.3 The Game

The artificial language was taught to learners with a game-like interface. They were provided with a brief storyline: they were playing as a child who is out for a walk in nature with an older friend who speaks a different language. They were told they would encounter "Sigi", and the friend would describe what "Sigi" was doing in his language, and they would have to pay attention to the way it was described. The use of a game-like interface has the advantage of focusing participants on the task.

6.3.2.3 Learning Task

The task was divided into three phases: a pre-training phase, a training phase, and a test phase. The pre-training phase was composed of 24 trials, which were fixed in order for all participants. The first 12 were Subject-Verb sentences, with each action repeated twice. The last 12 were Subject-Preposition-Object sentences, with each preposition repeated twice. This was done to familiarize participants with the basic vocabulary, so that they would be able to analyze the full sentences accurately in the training phase.

The 72 unique SVPO trials were divided into two equal groups, half for training and half for test. Half of

the trials in training and half of the trials in test were transitive, and the other half in each were intransitive.

At each training trial, participants would see "Sigi" perform a scripted action. The action would be some combination of a verbal meaning, a prepositional meaning, and an object meaning from the meanings specified in Table 1. Once the action was complete, a speech bubble would be displayed coming from the friend, which contained the sentence describing the action. The participant would then repeat the sentence in a text box that comes out from their avatar.

After training, there were two testing phases, each with 18 trials. Half of the trials were depicted a transitive event, and the other half depicted an intransitive event. In the first, participants saw an action that was either transitive or intransitive. After seeing the action, they were given a two-alternative forced-choice task between a a sentence with an affixed verb and one with a bare verb. The vocabulary was always correct, and was the same between the two alternatives. The only thing that differed was the affixation. In the second testing phase, participants saw an action and then were prompted with a sentence that had either an affixed verb or a bare verb. The prompt had the correct vocabulary and sentence structure. The affixation (affixed/unaffixed) of the verb was either consistent with the transitivity depicted in the action or inconsistent with it. The participant provided a rating on a 6-point scale, where 1 indicated that the provided sentence was not possible in the language they had learned, and 6 indicated that it was very possible.

6.3.3 Manipulation & Predictions

Two factors were manipulated. Participants saw the affix co-occur with only transitive events in some conditions (Transitive) or only intransitive events in others (Intransitive). The number of times affixation co-occurred with the particular event type was also manipulated. Affixation occurred 100% of the time, 66% of the time, or 33% of the time. I will refer to the 100% conditions as "consistent" and the 66% and 33% conditions as "inconsistent". Of the 36 training trials that a participant in the Transitive 66% condition saw, 18 were intransitive, and 18 were transitive (as with all other participants). Of the 18 transitive trials, 12 of them were shown being described with affixation while the remaining 6 were shown without affixation. No intransitive trials were ever shown with affixation. For a participant in the Intransitive 66% condition, 12 of the 18 intransitive trials were shown with affixation, and none of the transitive trials were.

On accounts where learner's inductive biases play a significant role, artificial language exposes the inductive biases and inferences that learners make about the input, the resultant generalization rates of affixation cuing (in)transitivity will reflect the natural/unnaturalness of the relationship between transitivity marking and verbs. Participants in inconsistent Transitive conditions should generalize affixation to all Transitive

events in the test phases, because it is natural (within-category generalization). Conversely, participants in inconsistent Intransitive conditions may generalize within-category, since valence-reducing morphology does exist.

On the other hand, a cue-based learning mechanism expects no asymmetry in generalization patterns across valence types. The cue is equally valid in both cases (at its requisite input frequency), and learner's biases play a slight role, so the fact that valence-increasing morphology is more natural than valence-decreasing morphology should not affect generalization rates.

6.3.4 Results

The results are presented by test stage. For each, there are two dependent measures of interest: the degree of within-category generalization, and the degree of cross-category generalization. Within-category generalization is measured by the production rate on trials of the category that saw affixation in training. In other words, responding with affixation on a transitive trial in the Transitive 33 condition figures in the calculation of within-category generalization. Responding with affixation on an intransitive trial in the same condition contributes to the other metric, cross-category generalization. The proportion of trials with affixation within-category and cross-category is the dependent measure of interest.

6.3.4.1 Test 1: Forced-choice

Figure 1 is a plot of within-category generalization for all conditions on Test 1. The plot shows a stark contrast in inconsistent conditions. In inconsistent transitive conditions, there was substantial within-category generalization. Especially striking was the Transitive 33, where there was so much within-category generalization that the output was more than double the rate of affixation in the input. The consistent transitive condition was by-and-large the same as input, despite some by-participant variability.

Across the Intransitive conditions, within-category response rates were about half of the input on average. Correspondingly, there was not only less generalization than the Transitive conditions, but fewer productions of the affix within-category than input. The contrast between conditions is quite strong. To confirm this, mixed logit regression was run on the proportion of within-category generalization using the maximal appropriate random effects structure. The final model tested effects of presentation consistency, the valence change of the affix, and their interaction.

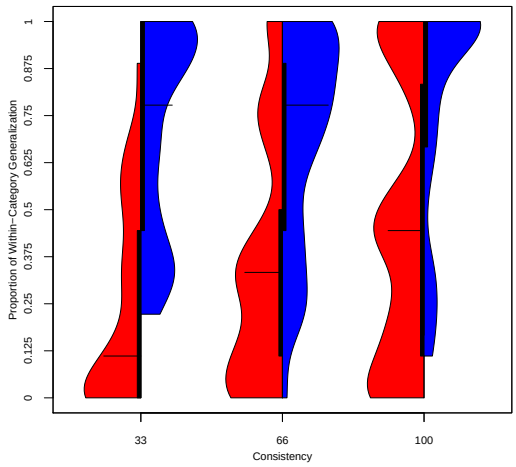


Figure 6.1: Violin plots of within-category generalization on the forced-choice task. Intransitive conditions are in red. Transitive conditions are in blue. Consistency is arrayed on the x-axis in increasing order. The main difference is the difference between Transitive and Intransitive conditions, with the former being higher than the latter in every case.

Level	β	z-score	p value
100:33	-0.3145	-1.799	0.0721
100:66	-0.9076	-5.111	$<.001$
Transitive:Intransitive	-0.8469	-4.781	$<.001$
Transitive 100:Intransitive 33	0.3323	1.29	0.197
Transitive 100:Intransitive 66	0.1544	0.609	0.5423
Transitive 33:Intransitive 66	-0.1776	-0.682	0.495439

The model confirms the observations from the plot: there are substantial differences between Transitive and Intransitive conditions on within-category trials. There is a main effect of valence change. Transitive conditions produced higher rates of the affix on within-category trials than Intransitive conditions. There was also a marginal interaction between the Transitive 100 and the Intransitive 33, indicating that the Intransitive 33 was lower than expected based on the effect of valence change and consistency. The reason for this interaction is anticipated in the plot: the within-category generalization rate is unexpectedly high in the Transitive 33, leading to small estimates in the difference between the two conditions. Since the Intransitive 33 is low, an interaction is the natural consequence.

Moving on to cross-category generalization, the plot is shown in Figure 2. The plot shows the higher rates of cross-category generalization in the Intransitive conditions than Transitive conditions. In general,

the rates of cross-category generalization in the Transitive conditions is consistent with learners separating the categories entirely: higher within-category generalization, and low across-category generalization. On the other hand, the Intransitive conditions are producing far more cross-category responses. The two patterns of behavior are in fact very similar. Indeed, the plot shows that both Transitive and Intransitive learners are associating the affix more with transitive events than intransitive events. The Intransitive learners are doing this by cross-category generalization, the Transitive learners by within-category generalization. The model results on cross-category generalization are given in the table.

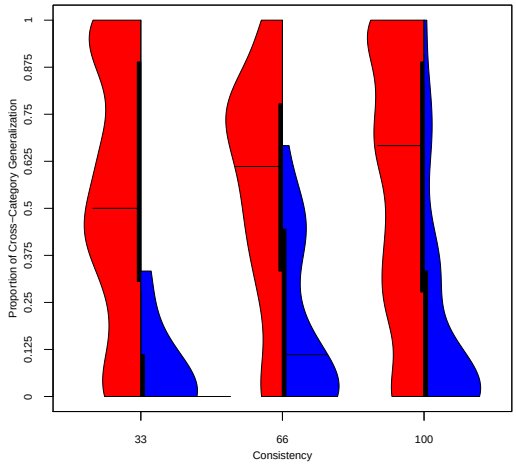


Figure 6.2: Violin plots of cross-category generalization on the forced-choice task. Intransitive conditions are in red. Transitive conditions are in blue. Consistency is arrayed on the x-axis in increasing order. Intransitive conditions are higher than Transitive conditions, with what appears to be a moderate increase as consistency increases.

Level	β	z-score	p value
100:33	-0.02747	-0.112	0.9108
100:66	-0.56393	-2.235	0.0254
Transitive:Intransitive	1.0256	4.41	$<.001$
Transitive 100:Intransitive 33	0.4102	1.233	0.2174
Transitive 100:Intransitive 66	-0.08446	-0.257	0.7969
Transitive 33:Intransitive 66	-0.4948	-1.479	0.1391

The model indicates the presence of a main effect of valence change. The Transitive 100 condition is also significantly different from the Transitive 33 condition, where there is less cross-category generalization in the 33 condition than the 100 condition. This is likely due to the higher variability in the Transitive 100

condition, because most learners were still close to 0 in the Transitive 100. In each Intransitive condition, learners produced variable output near 0.5, while in each Transitive condition, learners produced somewhat variable output near 0. There is a tendency for more variable conditions to have more variable outputs. This is shown by the longer/fatter tails in the 66 and 100 conditions. Ultimately, however, this difference does not reach significance. In sum, Transitive learners did not generalize across category, while Intransitive learners did. All learners are showing some preference for the affix to mark transitivity.

6.3.4.2 Test 2: Likert Rating

Figure 3 is a plot of within-category generalization for all conditions on Test 1. The y-axis depicts the average Likert rating on a by-participant basis to within-category trials.

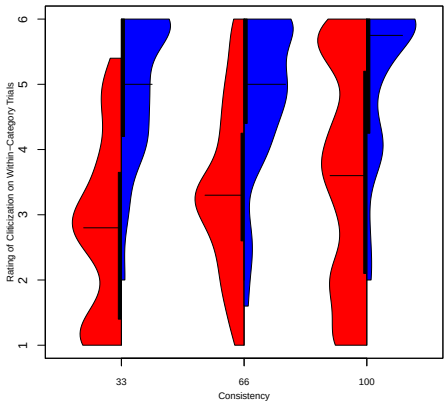


Figure 6.3: Violin plots of within-category generalization on the rating task. Intransitive conditions are in red. Transitive conditions are in blue. Consistency is arrayed on the x-axis in increasing order. Transitive conditions are rated higher than Intransitive conditions. Intransitive conditions also have higher variability.

The pattern in the plot is very similar for the Transitive conditions: higher ratings are given to affixes occurring with Transitive events. Intransitive learners on the other hand were generally near the midpoint of 3.5. This suggests that intransitive learners did not in general reject the pattern of affixation that they had witnessed, but they did not prefer it either. Mixed ordered logistic regression was run on the proportion of within-category generalization using the maximal appropriate random effects structure.[2] The final model tested effects of consistency and valence change.

[2]It is important to note that, unlike logistic regression or linear regression, it is not possible to infer what effects should exist on the basis of indicated means with mixed ordered logistic regression.

Level	β	z-score	p value
100:33	-0.7186	-1.646	0.0998
100:66	-2.1374	-4.949	<.001
Transitive:Intransitive	-2.5018	-5.781	<.001
Transitive 100:Intransitive 33	1.2887	2.157	0.031
Transitive 100:Intransitive 66	0.5313	0.881	0.3782
Transitive 33:Intransitive 66	-0.7574	-1.275	0.202208

Once again there is a main effect of valence change. One interaction is significant: the Intransitive 66 is worse than expected on the basis of the difference between the Transitive 33 and Transitive 66. This echoes what was found in Test 1. Overall the pattern resembles the one found from Test 1.

Moving on to cross-category generalization, the general pattern from Test 1 is repeated. This is shown in Figure 4. Learners in the Intransitive conditions were very willing to accept the affix as marking the transitive. The reverse was no true. Most Transitive learners rated the affix marking the intransitive poorly. These differences are once again confirmed by a model.

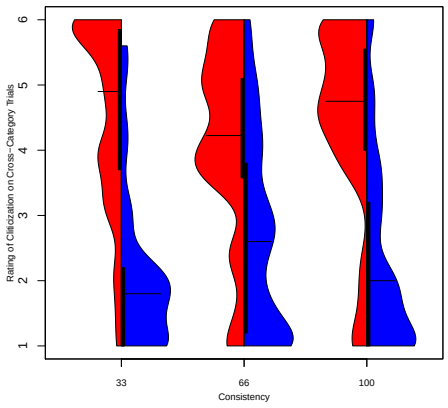


Figure 6.4: Violin plots of within-category generalization on the rating task. Intransitive conditions are in red. Transitive conditions are in blue. Consistency is arrayed on the x-axis in increasing order. Intransitive conditions have higher ratings than Transitive conditions, and consistently rate cross-category trials high.

Level	β	z-score	p value
100:33	0.689624	1.469	0.142
100:66	0.226437	0.487	0.626
Transitive:Intransitive	2.64725	5.684	<.001
Transitive 100:Intransitive 33	-0.009658	-0.015	0.988
Transitive 100:Intransitive 66	-0.547723	-0.838	0.402
Transitive 33:Intransitive 66	-0.538232	-0.828	0.408

There was a main effect of valence change. Intransitive conditions rated cross-category items higher than Transitive conditions. There was an interaction between the Transitive 33 and Intransitive 66, for the same reason as that interaction has occurred before. In sum, the results of Test 2 are similar to the results of Test 1.

6.3.5 Discussion

All learners produced the same basic pattern: they associated affixation more with transitive events than intransitive events. This manifested as high rates of within-category generalization in the Transitive conditions, and high rates of cross-category generalization in the Intransitive conditions.

The results show that the affix was used to mark a salient increase in verbal valence. This establishes the baseline expectations for the experiment on prepositional enclisis. Morphological changes to the verb should trend toward the salient case of transitivity. The interpretation is straightforward. Learners find an affix cuing transitivity with the verbs in the experiment to be far more natural than the same affix cuing intransitivity. The observed asymmetric pattern of generalization is inconsistent with cue-based learning. Even though learners in the Intransitive conditions saw the affixal cue just as reliably mark intransitivity only, they preferred it to mark transitivity like the Transitive conditions.

There are some possibilities for why learners might have preferred the affix to cue valence increases over valence decreases. One particularly salient possibility is that valence-increasing meanings are more complex. There is a documented tendency to associate longer words with more complex meanings both typologically (Klamar 2005) and experimentally (Fedzechkina, Jaeger, & Newport 2012). Consequently, the affixed form would be a more natural fit for a valence-increasing meaning. This possibility is weakly supported by trends in typological data. In a study of regular, productive morphological valence changing process, Nichols (1999:155) found that 103 possessed some form of valence-decreasing morphology, while 160 possessed a form of valence-increasing morphology. Both types are well-attested, but there is a distinct advantage for

valence-increasing morphology. On typological grounds, then, complex words should be slightly more likely to be analyzed as valence-decreasing or valence-increasing. If learners are sensitive to this, then it could have influenced the results.

6.4 Experiment 2: Valence-Increasing Prepositions

6.4.1 Motivation

The purpose of this experiment is to investigate whether learners will associate prepositions and verbs generally with transitivity in an artificial language learning experiment. Typologically speaking, there is ample reason to suppose this. For one, there is a tradition of analyzing applicative constructions as preposition incorporation (Baker 1988). Prepositions are also a documented source of causative affixes (Kulikov 2008), causatives being the other major valence-increasing category.

But more generally, I have argued in the preceding chapters that prepositions are primarily argument licensing functional heads in exotransitive/alternating/obligatory verbs. They have a unique semantics or featural composition that requires them to create a well-formed expression. Phenomena as diverse as agentive *by*-phrases in passives and argument structure alternations make clear that prepositions function in a unique way to license all necessary arguments.

Therefore, there is license to expect that learners associate prepositions and a valence-increasing function. Finding an inductive association in an experiment would support earlier contentions about the prepositions in general being considered as argument licensers. Learners have already demonstrated knowledge of the relationship between the preposition of an exotransitive and the argument of the exotransitive (Chapter 4). Consequently, the association should be strong enough to carry over to new input like an artificial language.

There are methodological constraints which require consideration here. In any design meant to test something about prepositions, it must be clear to learners that the items of interest *are* prepositions. To do so, they have to be established with familiar locative meanings and prepositional syntax. At the same time, something must change between transitive and intransitive trials in order for there to be an actual experimental manipulation. In other words, consider the stimuli from Experiment 1, but without the affix (118).

(118) Sigi romina tis wodi.

The preposition has to occur in every sentence in order for the experiment to not just be about the occurrence of an object between transitive and intransitive events. In order for there to be as little difference as possible

between transitive/intransitive events in such a way that the role of the preposition is highlighted, cliticization was used. Thus, the stimuli look like the following:

(119) Sigi romina tis wodi.

(120) Sigi rominattis wodi.

In this way, the preposition is still identifiable, the object is always present, and the spatial meaning can be represented. Critically, no word is morphologically complex in the sense that it would attract learners towards a valence-increasing meaning. All words are identifiable, with no added material that does not already have semantics that have been taught to the learner. This is quite unlike the addition of an affix, which both made the verb morphologically complex in the first experiment and made it longer. It has no semantics of its own to contribute, so all of the meanings of the individual categories and lexical items remain constant. It is still a morphological change, so the insights of Experiment 1 can be applied. Consequently, observed differences between conditions come down to the inferences that learners make about prepositions and their relationship to verbs modulo cliticization.

The drawbacks of cliticization as a manipulation are not as significant as might at first be supposed. In Paamese, for example, prepositional enclisis cues valence change (121b). The clitic preposition is still identifiable as a preposition, and not just as some other transitivizing morphology. What is particularly interesting about the Paamese example, however, is that the uncliticized variant is sometimes ambiguous between valence change and a prepositional construction (121a) (Crowley 2002). This paradigm is strictly analogous to the experimental manipulation, if the hypothesis that prepositions are inherently transitivizing is correct.

(121) a. na-musau eni sauene
1SG:REAL-sing to song
I sang the song.

b. na-musau-ni sauene
1SG:REAL-sing-to song
I sang the song.

So, while there may be reasonable concerns about using cliticization as a manipulation, those concerns should be limited to the fact that cliticization is inherently more variable than affixation. Concerns about the identifiability of the preposition in affixation or the meaning contribution are abrogated by the existence

of data like (121). Even so, any problems introduced by the use of cliticization are disadvantages shared equally by each condition. It thus does not bias the results in any particular direction. Ultimately, this design is about as close as can be achieved to the ideal case, where the stimuli change as little as possible and the differences come down to the relationship between prepositions and verbs.

6.4.2 Design

The game, learning task, and actions were the same as experiment 1. Most of the materials were the same, with the exception of cliticization. All prepositions began with a consonant so that gemination of the initial consonant of the preposition would be easily recognized. This resulted in a structure that is identical to affixation of the valence changing morpheme in experiment one, -CCVC.

6.4.2.1 Participants

450 participants were recruited over Amazon Mechanical Turk. They were paid $3 for their participation.

6.4.3 Manipulation & Predictions

Since artificial language exposes the inductive biases and inferences that learners make about the input, varying generalization rates of cliticization cuing (in)transitivity will reflect the natural/unnaturalness of the relationship between prepositional enclisis and (in)transitivity. Participants in inconsistent Transitive conditions should generalize cliticization to all Transitive events in the test phases, because it is natural (within-category generalization). Conversely, participants in inconsistent Intransitive conditions should not generalize within-category, since it is unnatural. They may generalize across-category, extending cliticization to be a general (and hence semantically unrelated) property of verbs and prepositions, akin to negative cliticization in English *do not* → *don't*. Participants in consistent conditions should reproduce the patterns they saw, regardless of the cuing relationship. This is because there is no inconsistency in their experience; one or the other relationship is cued perfectly. Once it is learned, there is no generalization necessary.

The manipulation is capable of demonstrating whether learners infer a general argument licensing relationship between prepositions and verbs. Learners would generalize in inconsistent Transitive conditions because they infer that prepositions and verbs are related through argument licensing. This is true whether learners apply their knowledge of English or some more general intuitions about transitivity. While it is true that the input is structured in a general way (cliticization occurs at least once to every preposition and every verb), it is the contrast between the unnatural inconsistent Intransitive conditions and the natural

Transitive conditions that makes this point. Only if learners infer that prepositions are generally related to transitivity (e.g as argument licensers *in general*) will they generalize in the Transitive conditions differently from the Intransitive conditions.

6.4.4 Results

6.4.4.1 Test 1: Forced-choice

Figure 5 depicts within-category generalization. Compared to the results of Experiment 1, the contrasts between the conditions are smaller. There is more variability overall, probably due to the inherently inconsistent nature of cliticization. Nevertheless, there are differences that follow the same form as Experiment 1. There is more within-category generalization in inconsistent Transitive conditions than inconsistent Intransitive conditions. Once again, inconsistent Intransitive conditions were producing fewer within-category responses than input, while inconsistent Transitive conditions were producing more. The table reports the results of a model with the same specifications as in Experiment 1.

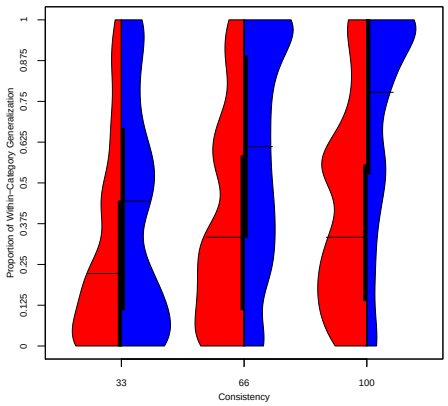


Figure 6.5: Violin plots of within-category generalization on the forced-choice task. Intransitive conditions are in red. Transitive conditions are in blue. Consistency is arrayed on the x-axis in increasing order. The main difference is the difference between Transitive and Intransitive conditions, with the former being higher than the latter, although there is greater variability than in Experiment 1.

Level	β	z-score	p value
100:66	-0.2106	-0.997	0.3187
100:33	-0.1849	-0.828	0.4076
Transitive:Intransitive	-0.9894	-4.338	<.001
Transitive 100:Intransitive 33	-0.6849	-2.029	0.0425
Transitive 100:Intransitive 66	-0.1465	-0.455	0.6494
Transitive 33:Intransitive 66	0.5835	1.591	0.11156

Moving on to cross-category generalization, Figure 6 shows the same general pattern as Experiment 1, but with greater variability. Like in Experiment 1, the Transitive conditions are closer to 0 while the Intransitive conditions are higher but quite variable. Overall, there was much more cross-category generalization in Intransitive conditions than Transitive ones. Model results are reported in the table below.

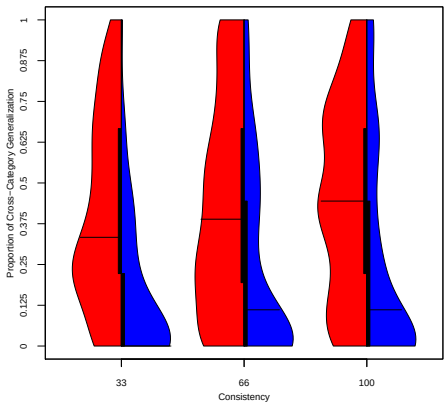


Figure 6.6: Violin plots of cross-category generalization on the forced-choice task. Intransitive conditions are in red. Transitive conditions are in blue. Consistency is arrayed on the x-axis in increasing order. Intransitive conditions are higher than Transitive conditions, with what appears to be a moderate increase as consistency increases.

Level	β	z-score	p value
100:66	-0.2106	-0.997	0.3187
100:33	-0.1849	-0.828	0.4076
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Transitive 100:Intransitive 66	-0.1465	-0.455	0.6494
Transitive 33:Intransitive 66	0.5835	1.591	0.11156

On the whole, the results of Test 1 are the same as the results of Test 1 in Experiment 1. Transitive conditions have more within-category generalization and less cross-category generalization than Intransitive conditions. The primary difference between the results of Experiment 1 and Experiment 2 are that the results are more variable across the board.

6.4.4.2 Test 2: Likert Rating

Figure 7 shows within-category generalization. Once again, the results are similar both to the within-category results of Test 1 and the results of Experiment 1. Transitive conditions appear overall more accepting of cliticization marking transitive events, while Intransitive conditions are more reticent to do the same for intransitive events. Model results are reported in the table.

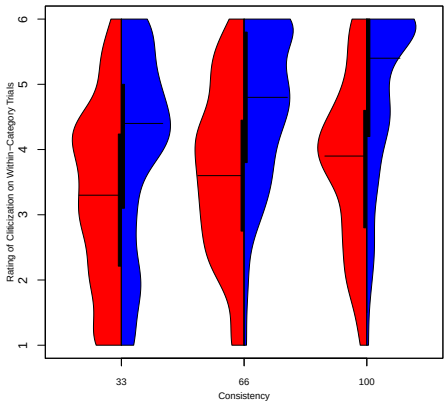


Figure 6.7: Violin plots of within-category generalization on the rating task. Intransitive conditions are in red. Transitive conditions are in blue. Consistency is arrayed on the x-axis in increasing order. Transitive conditions have moderately higher ratings than Intransitive conditions overall. There is substantial variability in the Intransitive conditions.

Level	β	z-score	p value
100:66	-0.2106	-0.997	0.3187
100:33	-0.1849	-0.828	0.4076
Transitive:Intransitive	-0.9894	-4.338	$<.001$
Transitive 100:Intransitive 33	-0.6849	-2.029	0.0425
Transitive 100:Intransitive 66	-0.1465	-0.455	0.6494
Transitive 33:Intransitive 66	0.5835	1.591	0.11156

Finally, the results for cross-category generalization are presented in Figure 8. Yet again, the results of very similar to that of Test 1 and Experiment 1, just with more variability. There is perhaps more variability here than expected even based on previous results, but it is not clear if that is significant even if it were true.

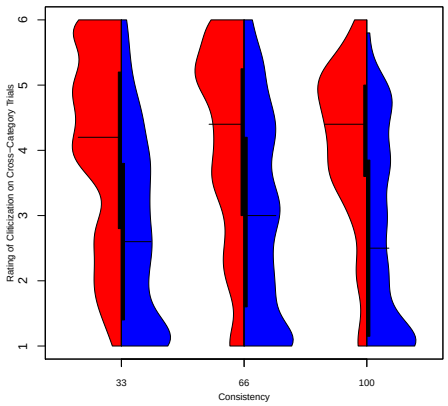


Figure 6.8: Violin plots of cross-category generalization on the rating task. Intransitive conditions are in red. Transitive conditions are in blue. Consistency is arrayed on the x-axis in increasing order. Intransitive conditions have higher ratings than Transitive conditions, and consistently rate cross-category trials high. There is considerable variability in both Transitive and Intransitive conditions.

Level	β	z-score	p value
100:66	-0.2106	-0.997	0.3187
100:33	-0.1849	-0.828	0.4076
Transitive:Intransitive	-0.9894	-4.338	$<.001$
Transitive 100:Intransitive 33	-0.6849	-2.029	0.0425
Transitive 100:Intransitive 66	-0.1465	-0.455	0.6494
Transitive 33:Intransitive 66	0.5835	1.591	0.11156

In conclusion, the results of Experiment 2 are very similar overall to the results of Experiment 1. Each pattern from Experiment 1 is replicated in Experiment 2, with the addition of significant variability. I discuss what this means below.

6.4.5 Discussion

The purpose of the preceding experiments was to uncover learners' preferential association between prepositions and in/transitive events. The technique of artificial language learning is useful for addressing this

question because, as established in Experiment 1 but also shown by Experiment 2, it reveals learning biases. The experiments were designed to reveal learner's biases about the relationship first between verbs and valence-changing morphology and second between verbs and valence-changing prepositions.

The findings between the two experiments were largely the same. In general, all learners pushed the affix and cliticization towards marking transitivity. In the Transitive conditions, this meant high within-category generalization. In Intransitive conditions, it meant high cross-category generalization. This pattern was found for both forced-choice and rating tasks across both experiments. The main difference between the two experiments was that cliticization induced more variability than affixation. This is to be expected, given the greater variability of cliticization as a process both within English and cross-linguistically.

Even though the by-participant variability is to be expected, it is still problematic for making broad claims about learners implicitly associating prepositions with transitivity. That is, although there was a clear tendency to associate prepositions with transitivity, there was also a number of participants doing the opposite. In order to go from observations of a tendency to a statement about learner's implicit knowledge about prepositions and transitivity in English, it is preferable to be able to explain the totality of behavior in a consistent way that also supports that conclusion. In the next section, I introduce a model of language learning that captures the results in a consistent way and which also demonstrates that learners did in fact have a preference for associating prepositions with transitivity.

6.5 Modeling the Results

6.5.1 Measures and Approach

To back up the conclusions, the results of the experiments were modeled using a variant of the Double Sigmoid Scaling model (DSS) (Schumacher & Pierrehumbert 2017; Schumacher & Pierrehumbert, submitted). From a theoretical point of view, the DSS is useful because it is designed to handle data with substantial individual variation (Schumacher & Pierrehumbert 2017). Preferences for systematicity and for particular systems are determined independently, allowing for wide the range of behaviors observed in the experiment to be captured potentially in a consistent way. These advantages make it preferable to more typical approaches (i.e Bayesian modeling) because, for example, in the widely-used beta-binomial implementation, the prior is forced to do double duty as a preference for particular systems and as a preference for regularity. By allowing these preferences to be specified independently, the observed heterogeneity has a better chance of being captured.

The DSS was fit to a measure derived from the data. First, the forced-choice results were coded as proportions of productions of a morphosyntactic change on transitive trials and proportions of the change on intransitive trials. Then, the results of the rating task were converted to forced-choice responses by classifying a response of a 4 or greater as equivalent to selecting that the event and label combination on the forced-choice task, and a 3 or lower as selecting the opposite label. The results of both tasks were then added together to create totals of the change on transitive trials and intransitive trials for each participant.

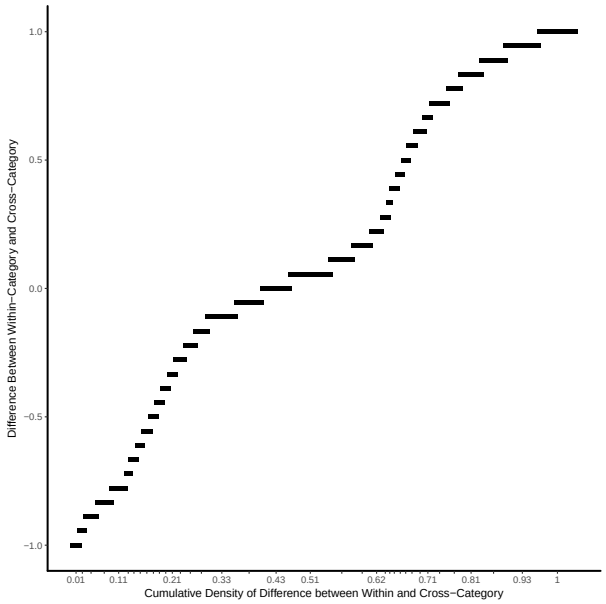


Figure 6.9: CDF-PDF Plot of the Difference between the Measures

The model was then fit to the *difference* between these measures. A plot of the density of the difference between the measures is given in Figure 9. The reason that the model was fit to the difference rather than the each of measures separately was because learners were not treating them independently. The correlation between the proportion of within-category responses and cross-category responses was -0.68. Since responses on each of the measures were correlated, it is plausible that learners were treating the input as part of a single system, which is composed of both within-category and cross-category production rates. Consequently, it is most appropriate to fit the model to the difference between the production rates.

One factor to consider is how the presentation of two alternatives, a bare form and an affixed one, affected production rates relative to the frequency of occurrence in the input. For example, learners in the 33 conditions produced far more on test than the total (0.165) amount of cliticization/affixation they saw. The input proportion was corrected by 0.21 in the 33 conditions, for a total of 0.54 and by 0.12 in the 66

conditions for a total of 0.78. Therefore, a correction was applied to the production rates.

Since the results are highly variable within and across conditions, fitting to all responses necessarily obscures important and systematic individual differences. Therefore, the model was fit on a by-participant basis. However, since the model has two free parameters, there are multiple solutions for a given point and thus optimization is required to find a unique solution. The fits were done with a brute-force optimization method. Since there was only a single data point per participant, no gradient optimization methods are possible. In the present case, however, reaching a unique solution is relatively simple. The search space is small, since the function domain is between -1 and 1, the number of free parameters is low (only 2), and the model is monotonically increasing, meaning that there is a unique solution at the first point for a combination of the parameters that minimizes the squared error.

6.5.2 The Double Sigmoid Scaling Model

The DSS is based on the logit of the natural logarithm. The term p is the input proportion.

$$logit(p) = \ln\left(\frac{p}{1-p}\right) \tag{6.1}$$

In the present case, p is the difference between production rates of the morphosyntactic change on transitive and intransitive trials. This is always the input proportion, since the presence of a morphosyntactic change was always 0 cross-category. These measures were normalized into proportions on a scale ranging from -1 to 1, where -1 was 100% productions of morphosyntactic change on intransitive trials with 0 productions on transitive trials, and 1 is the opposite. Because the logit is only defined when $0 \geq p \leq 1$, p was transformed on to that scale when input to the model , and then transformed back in the output.

The inverse of the logit is the logistic. The composition of the logit with the logistic is the line $y = x$, e.g where the input is the same as the output.

$$p = \frac{1}{1 + e^{-\left(\ln\left(\frac{p}{1-p}\right)\right)}} \tag{6.2}$$

The logit is interpretable as log odds. Log odds has been shown to highly successful at capturing distortions of input frequency in probabilistic reasoning (Zhang & Maloney 2012).

Through the addition of a scaling factor c, non-linearity is introduced, and the model takes on its characteristic double sigmoid shape (Fig. 9, cf. Fig. 8). For part of the domain of p, higher values of c will cause rapid scaling towards the extremes of -1 and 1. A flat region at 0.5 is also introduced. The flat

region becomes flatter and wider as c increases. Consequently, changing the value in the middle of the range of p causes little change in the output. The flat region is interpretable as the input range where there is insufficient evidence for the learner to infer a regularization-inducing rule. The scaling factor is added to (2) before transforming the logit back into probabilities.

$$f(p) = \ln\left(\frac{p}{1-p}\right)^c \tag{6.3}$$

Where $c \geq 1$, values get pushed to the extremes or 0.5 depending on the value of c. This helps account for learners in the 66 conditions who increased the within-category proportion.

The scaling factor allows the model to produce regularization. However, the model is still rotationally symmetric by 180° around (0.5, 0.5). As it stands, this means that every system will be treated equally. This is inadequate for the experimental data, since learners manifestly prefer marking the transitive over marking the intransitive. To explain the behavior of these participants, a horizontal bleed parameter is added, as in (3).

$$f(p) = \ln\left(\frac{p-b}{1-p}\right)^c \tag{6.4}$$

The bleed parameter b was constrained to be $\leq 2p$, so that the maximum effect is to flip all of the instances of within-category generalization to cross-category. The final version of the bleed DSS is (5).

$$Output(p|b,c) = \frac{1}{1+e^{-\ln\left(\frac{p-b}{1-p}\right)^c}} \tag{6.5}$$

Before continuing, a word on the relationship of bleed to the bias parameter used by Schumacher and Pierrehumbert (2017) is warranted. Schumacher and Pierrehumbert add a free parameter b_j to the logit, which moves the center of the function left or right.

$$f(p) = \left(\ln\left(\frac{p}{1-p}\right) + b_j\right)^c \tag{6.6}$$

From a mathematical standpoint, it is arithemtically true that there is some unique value of bleed b that corresponds to b_j for the same values of c and p[3]. From that standpoint, there is no difference in the implementation of bias in Schumacher and Pierrehumbert (2017) and the one presented here. What is

[3]That is,

$$b = \ln\left(\frac{p-b}{1-p}\right) - \ln\left(\frac{p}{1-p}\right) \tag{6.7}$$

different is how it is constrained and interpreted. In Schumacher and Pierrehumbert (2017), bias was unconstrained. Its function was to push the function overall left or right, causing one system to be favored overall. However, in the current case, the scale is different, comprising two separate measures. The bleed parameter b is specifically designed for the case of cross-category allocation; the bias parameter b_j is not. Along similar lines, the bleed parameter is constrained to be interpretable in those terms - that is, as re-allocation of observed instances of a morphosyntactic change. For this reason, a bleed implementation of bias rather than an additive one is used.

Figure 10 illustrates the behavior of the model with a sample of values for b and c. The model takes a probability as input and outputs a probability.

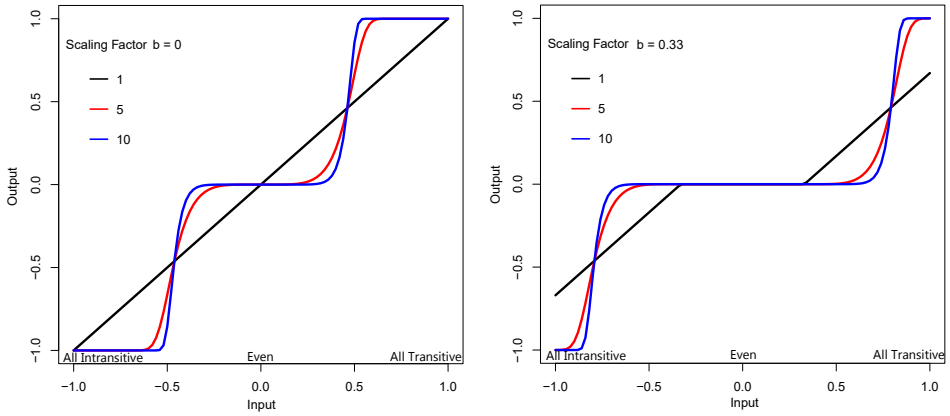


Figure 6.10: Function plots of the DSS for various combinations of free parameters. Both panels show the plots for $c = 1$, $c = 5$ and $c = 10$. LEFT PANEL Function plot when $b = 0$. RIGHT PANEL Function plot when $b = 0.33$.

By manipulating b and c, a number of patterns in the results can be explained. The high amount of transitive productions in Intransitive conditions can be understood as high values of bleed, sometimes in conjunction with a high scaling factor. The presence of cross-category generalization in Transitive conditions can be understood as small amounts of bleed, while their general preference for the Transitive is explained by the scaling factor. On the basis of these considerations, the DSS appears to be capable of capturing the data.

6.5.3 Results of Fitting

The quality of the fit of the DSS to the data is assessed by how consistent its fits are within conditions. In other words, how spread out are the distributions, and how many modes do they have? Ideally, the

distributions should be highly concentrated around only a single mode. This is because learners should be approximately the same in how they learn and process the input. Admitting some freedom for learners to come to a different analysis of the data or to vary in the initial settings of their free parameters, however, some variability is tolerable. Since the data only concern what learners produced *after* training, the parameters themselves may represent acquired knowledge or the combination of inherent biases and acquired knowledge. Additional considerations will be given to consistency across conditions, but because the parameters represent a post-training state, there is no *primae facie* reason for them to be (highly) consistent with one another.

The first plot is a plot of the scaling factor. Transitive conditions are in blue, Intransitive conditions are in red. Consistency is arrayed on the x-axis in increasing order.

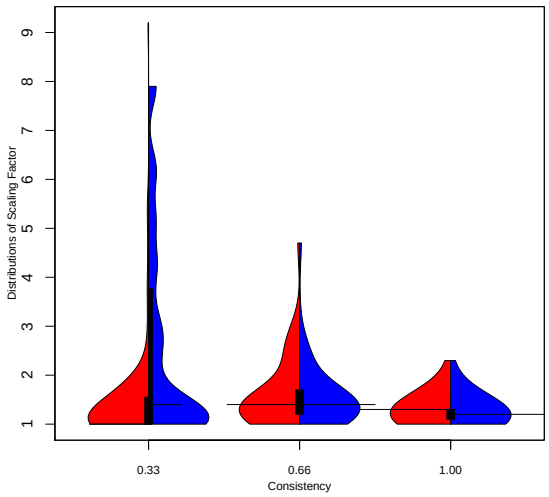


Figure 6.11: Plot of scaling factor by Condition

The distributions of scaling factor are similar within and across conditions. The majority of the mass in each distribution is between 1 and 2, close to the lower bound of 1. Nevertheless, there is a trend for longer tails as consistency decreases, with the Transitive 0.33 especially having a long, prominent tail. The individuals on this tail are ones who produced an exceptionally large amount of within-category responses, and so the model needs higher scaling factors to handle this regularization. Even so, the majority of responses in all conditions is in the same small range.

The second plot is a plot of the bleed parameter. Since the bleed parameter was constrained to be $0 \geq b \leq p$, the distributions were normalized so that the y-axis represents the maximum (p) for each of the

conditions.

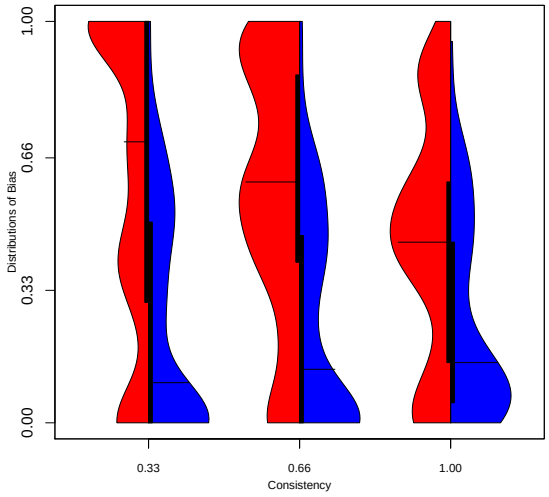


Figure 6.12: Plot of Bias by Condition

The distributions are similar within the categories of Transitive and Intransitive. Across each consistency, the Transitives have a low mode, and then a long tail reaching out to the middle of the range. The Intransitives are spread out across the range, with a mode in the middle of the range and one towards the high end. The divergence between Transitive and Intransitive conditions represents the hypothesized bias towards the Transitive. In Intransitive conditions, bleed operates to the benefit of the Transitive. Therefore, the higher values of bleed indicate a preference for marking the transitive. On the other hand, the low values of bleed in the Transitive indicate a preference for marking the Transitive as well, since these represent very small amounts of bleed over to marking the intransitive. There is still some variability that is not explained by a general preference for the transitive, especially the low values in the Intransitive and the middle values in the Transitive. These may represent subpopulations of learners who in the former case preserved and reproduced the input, and in the latter case who analyzed the morphosyntactic change as applying equally to transitive and intransitive cases alike.

In the final counting, however, the DSS is successful at capturing the extreme variability in the responses. At the same time, it contributes to the case for a general preference for a morphosyntactic change - especially in this case cliticization by a preposition to the verb - to mark transitivity. This is shown by the fact that the highly variable data can be captured with a single model, and the distributions of parameters are in a

direction that favors a preference for transitivity.

6.6 General Discussion

The preceding work has demonstrated that learners have a preference for associating morphosyntactic changes with a valence-increasing function over a valence-decreasing function. This is true of affixes (Experiment 1) and encliticized prepositions (Experiment 2).

The events depicted in this experiment were related abstractly. They were all motion events with some spatial orientation. Learners generalized from specific instances of prepositional enclisis with some combinations to other combinations. This is in fact exactly what I have been trying to establish: prepositions are like valence-increasing morphology with verbs according to their semantics. The results of Experiment 2 thus provides evidence that prepositions are interpreted generally as valence-increasing morphology with verbs.

What does this mean for the relationship between prepositions and transitivity? Manifestly, prepositional enclisis was preferred to signal a valence-increasing change over a valence-decreasing one. This is consistent with the idea that it is natural for prepositions to license arguments - because prepositions are argument licensing functional heads. When the preposition takes an argument, and cliticizes to the verb, the resultant expression is a better representation of a transitive event than the opposite.

6.7 Summary

In this chapter, I presented experimental evidence that English-speaking learners make an implicit association between prepositions and the valence system of an artificial language. This implicit association is attributable to their experience in English, where prepositions do participate significantly in the valence system.

The experiment contrasted the degree to which learners associated cliticization by a preposition to a verb with intransitive events with the degree to which they associated the same cliticization with transitive events. Learners showed a marked preference for associating cliticization with transitive events. This manifested both in high within-category generalization when the cliticization marked the transitive, and high cross-category generalization when the cliticization marked the intransitive. These findings support the idea that English learners implicitly associate prepositions with transitivity.

The data were modeled using the DSS to back up the conclusions, particularly about the contribution of a bias for cliticization to mark the transitive. The results were fit on an by-participant basis. The resulting

distributions of free parameters were relatively consistent, and they show a preference in both Transitive and Intransitive conditions for the association of a morphosyntactic change (including prepositional enclisis) with transitivity.

CHAPTER 7

Prepositions Beyond Exotransitivity: Arguments, Adjuncts, and Nouns

7.1 A Comprehensive Overview of Prepositional Uses

Most of the preceding chapters has been dedicated toward understanding and analyzing the interaction of prepositions and transitivity in English, especially as it relates to exotransitive verbs. The analysis touched on lexical, morphological, syntactic, and semantic aspects.

This chapter is dedicated to applying the analysis of exotransitive verbs to other cases of prepositions, in all of their various manifestations. To do this, I first review the analysis in all of its components. After laying this out, I will discuss how the picture of prepositions and arguments that emerges from the in-depth analysis of exotransitive verbs adds to the understanding of prepositions in the syntax and semantics more generally. The particular areas of interest are alternating/obligatory verbs, prepositional adjuncts, and nominal uses. Finally, returning to the questions often raised in the literature (Chapter 3), I conclude with commentary on what this means for prepositions as a category.

7.2 The Theory of Prepositions and (Exo)transitivity

7.2.1 In the Lexicon

In Chapter 4, I proposed (122) as the lexical representation for exotransitive verbs, using *participate in* as an example:

(122)

$$\begin{bmatrix} \textit{participate in} & & \\ \textsc{copy-index} & \textcircled{1}\,\textcircled{2} & \\ \text{participate} & \begin{bmatrix} \textsc{cat} & \text{verb} \\ \textsc{tense} & \text{pres} \\ \textsc{voice} & \text{active} \\ \textsc{mood} & \text{indicative} \\ \textsc{tel} & \text{atelic} \\ \textsc{index} & \textcircled{1} \end{bmatrix} \\ \text{in} & \begin{bmatrix} \textsc{cat} & \text{prep} \\ \textsc{subcat} & \langle \text{NP} \rangle \\ \theta & \textsc{Theme} \\ \textsc{case} & [\textsc{acc}] \\ \textsc{index} & \textcircled{2} \end{bmatrix} \end{bmatrix}$$

The representation (122) was motivated by several considerations. Primarily, it was a response to the problem of ensuring that both the preposition and the verb will necessarily co-occur. In Minimalist terms, this amounts to ensuring that they both occur in the numeration. Positing a distinct mode of lexical representation like (122) that contains feature bundles itself was necessary because established mechanisms like selection are insufficiently detailed to account for the relationship between exotransitives and their preposition. The processing studies in Chapter 4 also showed that lexical access of the verb leads to corresponding information about the preposition. All of these issues are resolved by (122). The COPY-INDEX ensures that both feature matrices will be copied into the numeration at the syntax-lexicon interface.

(122) has three features which distinguish it from lexical entries as they are traditionally understood. The first is the fact that the entry is *non-atomic*, meaning that it is composed of more than one distinct bundling of features. These bundles will enter the numeration separately according to their other distinguishing feature, the copy-index. Finally, (122) shows a distinct division of verbal functions into the two feature matrices. In particular, *in* is responsible for selection and theta marking, while the verb carries all of the verbal meanings (VOICE, MOOD, TENSE,, etc.).

Although it is not entirely clear how to reconcile articulated lexical representations like (122) with exoskeletal syntax, I will suppose, following Borer (2005b), that some kind of lexical relationship is necessary between exotransitive verbs and their preposition. Depending on the requirements, lexical representations like (122) can be abstracted or adjusted as necessary to accomplish the assimilation of transitive and exotransitives in exoskeletal syntax. By continuing to suppose that both null and overt prepositions license internal arguments, a general form that encompasses all transitive verbs is possible (123).

(123)

$$\begin{bmatrix} \textit{Generalized Transitive Verb} & \\ \text{COPY-INDEX} & \textcircled{1}\,\textcircled{2} \\ \text{VERB} & \begin{bmatrix} \text{CAT} & \text{verb} \\ \text{TENSE} & \\ \text{VOICE} & \\ \text{MOOD} & \\ \text{TEL} & \\ \text{INDEX} & \textcircled{1} \end{bmatrix} \\ P & \begin{bmatrix} \text{CAT} & P \\ \text{SUBCAT} & \langle \text{NP} \rangle \\ \theta & \\ \text{CASE} & [\text{ACC}] \\ \text{INDEX} & \textcircled{2} \end{bmatrix} \end{bmatrix}$$

The representation (123) captures exotransitive and simple transitive verbs in the same way. Their only difference is the licensing head, $P_\emptyset$ for simple transitives, P for exotransitives.

7.2.2 In Morphology

Not much effort was directed at a morphological treatment of exotransitive verbs in the preceding chapters, but with the observation in Chapter 5 that prepositions sometimes realize morphosyntactic features for verbs, one is beckoning. Recall the equivalence I drew between the realization of certain prepositions with verbs and morphological categories:

Degree	Realization	Example
Positive	$\emptyset$	wet
Comparative	*-er*	wetter
Superlative	*-est*	wettest

Degree	Realization	Example
Unaffected	*at*	kick at the ball
Mildly Affected	*into*	kick into the ball
Fully Affected	$\emptyset$	kick the ball

Assuming that prepositions group similarly on the other dimensions (affectedness, path boundedness, directness of experience)[1], this is cause to think of prepositions as inflectional affixes. Nevertheless, there is abundant syntactic evidence that they are not bound morphemes. This appears to rule out a morphological account on the grounds that prepositions simply do not concatenate with the verb.

This conclusion would be premature, however. Whole words may act as morphology according to a line of research known as COLLOCATIONAL MORPHOLOGY (Ackerman & Stump 2005; Bonami 2015). Collocational

[1] And also as-yet undiscovered ones, which surely still lurk in the inventory of exotransitive, obligatory and alternating verbs.

morphology focuses mainly on the interaction of periphrastic phenomena with inflectional paradigms, and how they can be reconciled into a broader morphological system. In such approaches, periphrastic and synthetic tense expressions, such as in (124), belong to one and the same mechanism.

(124) a. The sodium chloride crystallized overnight.

b. The sodium chloride did crystallize overnight.

The logic of treating whole words as morphological in character is based most firmly on alternations like those in (124), and also the cases in which periphrastic constructions fill out cells in inflectional paradigms that are otherwise synthetic. Latin provides a good example of this in its paradigm of the passive indicative. The paradigm is synthetic in the present, imperfect, and future, but periphrastic in others. The table below demonstrates this with the first conjugation verb *amare* "to love".

	Present	Imperfect	Future	Perfect	Pluperfect	Future Perfect
1st Singular	amor	amabar	amabor	amatus sum	amatus eram	amatus ero
2nd Singular	amaris	amabaris	amaberis	amatus es	amatus eras	amatus eris
3rd Singular	amatur	amabatur	amabitur	amatus est	amatus erat	amatus erit
1st Plural	amamur	amabamur	amabimur	amati sumus	amati eramus	amati erimus
2nd Plural	amamini	amabamini	amabimini	amati estis	amati eratis	amati eritis
3rd Plural	amantur	amabantur	amabuntur	amati sunt	amati erant	amati erunt

In the Latin paradigm, the passive indicative is expressed by the combination of a participle (that agrees with the subject in number) and the copula *esse*, inflected for tense and for agreement with the subject in person and number. On a strictly synthetic view of morphology, it is questionable to say that Latin has a passive form of the perfect, pluperfect, and future perfect indicative because there is no single form that corresponds to these meanings. By incorporating periphrasis into a wider theory of morphology, it is possible express the intuition that Latin forms its perfect, pluperfect and future perfect passive indicative by the combination of a participle and copula. Participles and copulas are whole words, but together they fill out morphological paradigms.

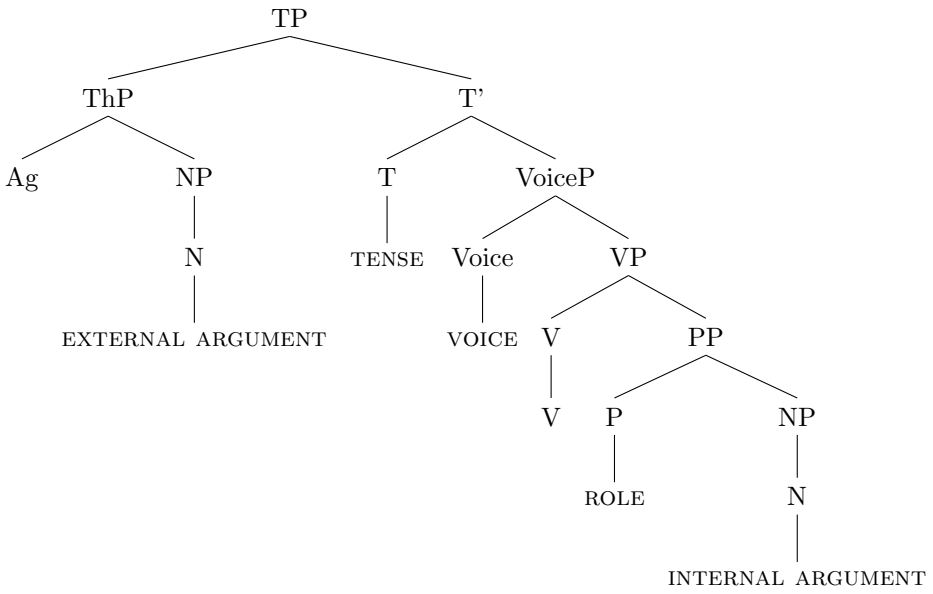
Assuming that collocational morphology is correct in viewing periphrastic constructions as morphological, prepositional occurrence with verbs fit neatly within collocational morphology. Like periphrastic tense auxiliaries, the preposition expresses some morphosyntactic property by virtue of its occurrence. That the preposition is obligatory is perhaps a way in which periphrasis and exotransitivity depart from each

other, but this is a relatively insignificant difference.

7.2.3 In Syntax

Verbs do not license arguments in the syntax. Arguments occur when taken by heads with the capacity to license them. In the case of transitives, this head is F; in the case of exotransitives, it is P. On this view, all transitive verbs have the same basic structure, shown in (125).

(125)



Exotransitives and simple transitives both fit in with (125). Their only difference is that the licensing head is a preposition with exotransitives, and a null head P with simple transitives. Some property of the verb determines the whether it will use an overt P rather than $P_{\emptyset}$ to license the internal argument. When a preposition is required to realize a necessary morphosyntactic or semantic property for the verb, a P will license the internal argument. When it is not, $P_{\emptyset}$ will license the internal argument.

7.2.4 In Semantics

Transitive and exotransitives are linked to their arguments in the semantics in the same way. By adopting full thematic separation, arguments are introduced into the semantics by a separate head; I have proposed that the heads capable of doing this are the heads $P_{e}mptyset$ and P_{p}, which evaluate to thematic predicates (reproduced below).

(126) a. $[\![P_{ag}]\!] \simeq \lambda x \lambda e[\text{Agent(e, x)}]$

b. $[\![P_{th}]\!] \simeq \lambda x \lambda e[\text{Theme(e, x)}]$

c. $[\![P_{instr}]\!] \simeq \lambda x \lambda e[\text{Instrument(e, x)}]$

d. $[\![P_{src}]\!] \simeq \lambda x \lambda e[\text{Source(e, x)}]$

e. ...

(127) a. $[\![\text{by}]\!] \simeq \lambda x \lambda e[\text{Agent(e, x)}]$

b. $[\![\text{on}]\!] \simeq \lambda x \lambda e[\text{Theme(e, x)}]$

c. $[\![\text{with}]\!] \simeq \lambda x \lambda e[\text{Instrument(e, x)}]$

d. $[\![\text{from}]\!] \simeq \lambda x \lambda e[\text{Source(e, x)}]$

e. ...

Members of category P can evaluate to the same thematic predicates. This explains prepositional/null exponence with the same thematic role like in *escape (from)*. In this way, exotransitives and transitives will have their arguments linked to interpretation in the same way.

7.2.5 Prepositions and Exotransitive Verbs

In the preceding sections, the analysis of exotransitive verbs as transitive was laid out in full. Broadly stated, exotransitives are precisely the same as transitives mechanically. What separates transitives and exotransitives is the requirement of the verb for some morphosyntactic or semantic feature to be realized. This feature can only be realized by a preposition, and so a preposition occurs in the local structural context of the verb and licenses its argument.

The insights of the experiment in Chapter 6 come in to play here. In that experiment, learners were associating prepositions with transitivity far more than they were with intransitivity. Since artificial language learning paradigms can expose inductive biases that learners possess, the preference for associating prepositions with transitivity suggests that there is something inherent to prepositions that presents themselves as transitivizing. In other words, the results support the view that prepositions are part of the argument licensing system in the grammar. This comports well with the picture of prepositions in exotransitives that has been developed to this point. However, a number of other prominent classes and uses of prepositions exist. The question beckons: can this view of prepositions as argument licensers that realize morphosyntactic/semantic properties be extended to the remaining cases? This question is taken up in the remainder of this Chapter and dissertation.

7.3 Beyond Exotransitivity

7.3.1 Other Verb-Preposition Combinations

Throughout this dissertation, I have referenced obligatory and alternating verbs as useful foils for exotransitives. Even though they are distinct classes, they share important similarities with exotransitives. Now that a thorough analysis of exotransitive verbs is in place, their analysis can be extended to obligatory and alternating verbs. Like exotransitive verbs, there are three specific questions for each: what is the lexical representation, what is the syntactic representation, and how are the arguments of the prepositions linked to the verb interpretationally? The answers are slightly different for each verb type; therefore, they are treated in turn.

7.3.1.1 Obligatory Verbs

Consider first the simpler case of obligatory verbs. Like exotransitives, obligatory verbs have an obligatory direct object and an obligatory prepositional dependent.

(128) a. Crassus devoted his fortune *(to Rome).

b. Some Bolshevik officials never officially distanced themselves *(from the Czar).

The generalized transitive representation in (123) is a good starting point. The motivation for a lexical association between the verb and preposition in exotransitives applies to obligatory verbs. Namely, the prepositional dependent is both obligatory and rigidly designated. The preposition should therefore be included in the lexical representation, as it is with exotransitives.

The only difference between exotransitives and obligatory verbs is the presence of the direct object. By hypothesis, the internal argument is licensed by a null preposition. The addition of a null prepositional head to the generalized exotransitive entry (123) is all that is required to explain the difference. So, for an obligatory verb like *devote*, the representation is (129).

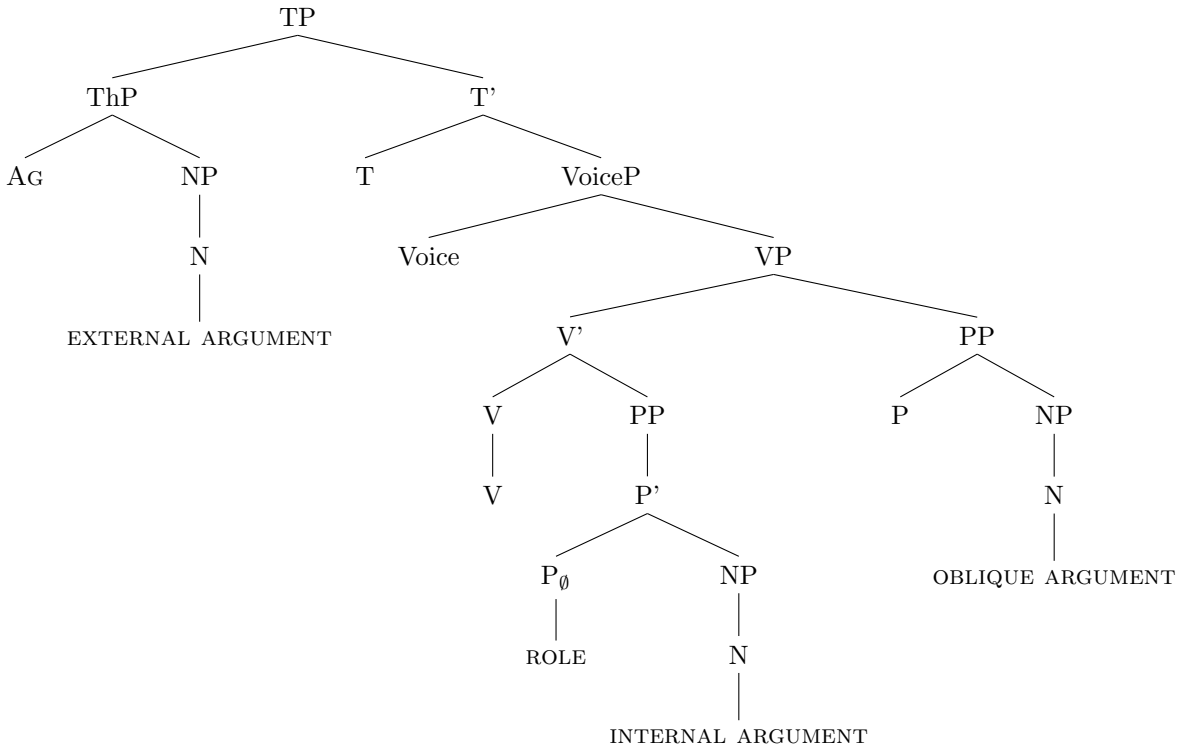
(129)

$$\left[\begin{array}{ll}
\textit{devote to} & \\
\textsc{copy-index} & \textcircled{1}\,\textcircled{2}\,\textcircled{3} \\
\text{devote} & \left[\begin{array}{ll}
\textsc{cat} & \text{verb} \\
\textsc{phon} & [\text{dɪvout}] \\
\textsc{tense} & \text{pres} \\
\textsc{voice} & \text{active} \\
\textsc{mood} & \text{indicative} \\
\textsc{akt} & \text{atelic} \\
\textsc{index} & \textcircled{1}
\end{array}\right] \\
\text{P}_{\emptyset} & \left[\begin{array}{ll}
\textsc{cat} & \text{P} \\
\textsc{phon} & \\
\textsc{subcat} & \langle \text{NP} \rangle \\
\theta & \textsc{theme} \\
\textsc{case} & [\textsc{acc}] \\
\textsc{index} & \textcircled{2}
\end{array}\right] \\
\text{to} & \left[\begin{array}{ll}
\textsc{cat} & \text{prep} \\
\textsc{phon} & [\text{tu}] \\
\textsc{subcat} & \langle \text{NP} \rangle \\
\theta & \textsc{recipient} \\
\textsc{case} & [\textsc{dat}] \\
\textsc{index} & \textcircled{3}
\end{array}\right]
\end{array}\right]$$

The selectional and subcategorization requirements of each of the constituent parts (V, $\text{P}_{\emptyset}$, P_{p}) are specified and satisfied locally. It ensures that both the object and the specific preposition *to* will appear, and in every case, by extending the copy-index to each part.

The question concerning the syntactic representation of obligatory verbs is a complicated one. Proposals have ranged from a trinary branching structure (Carrier & Randall 1992) to small clause structure (Den Dikken 1995) to more modern approaches, in which the direct object is generated in Spec_vP, and the PP is the complement of the verb. I will leave open the possibility that obligatory verbs are a heterogenous class, but I note that the conjunction of exoskeletal syntax and full thematic separation make the simplest structural analysis available. That is, the indirect object of obligatory verbs could be adjuncts structurally.

(130)



An adjunct structure is consistent with Minimalist derivational principles (i.e, the structure is binary branching and the derivation obeys cyclicity).

The main objection to an adjunct structure for indirect objects concerns how the indirect object relates to the verb. Arguments are supposed to associate with verbs syntactically to be licensed (i.e, receive, when necessary, case and theta roles). But this is not a problem with exoskeletal syntax. Verbs do not possess this capacity. Instead, it is prepositions (and F) which do. As such, no problems arise from indirect objects being adjuncts. The only question is how the are linked to interpretation. This can be accomplished in precisely the same way as it is with exotransitives. The preposition evaluates to a thematic predicate, meaning that the argument is linked appropriately and in the same way as the internal argument. So, while the possibility that obligatory verb are heterogenous is acknowledged, even the simple adjunct structure is consistent with the analysis.

7.3.1.2 Alternating Verbs

The requirements for capturing alternating verbs are more complicated than obligatory verbs because alternating verbs are more variable. There are PP/CP alternating verbs, PP/DO alternating verbs, and PP/$\emptyset$ alternating verbs. In what follows, I will focus as much as possible on the generalities of an analysis that would encompass all three types.

Consider how the traditional view of the lexicon and variable subcategorization would handle a reliably CP/PP alternating verb like *comment (on)*. In that view, there are two lexical entries for *comment*, $comment_{CP}$ and $comment_{on}$.

(131)

$$\begin{bmatrix} comment_{CP} & \\ \text{comment} & \begin{bmatrix} \text{CAT} & \text{verb} \\ \text{TENSE} & \text{pres} \\ \text{VOICE} & \text{active} \\ \text{MOOD} & \text{indicative} \\ \text{AKT} & \text{telic} \\ \text{SUBCAT} & \langle \text{CP} \rangle \end{bmatrix} \end{bmatrix}$$

(132)

$$\begin{bmatrix} comment_{on} & \\ \text{comment} & \begin{bmatrix} \text{CAT} & \text{verb} \\ \text{TENSE} & \text{pres} \\ \text{VOICE} & \text{active} \\ \text{MOOD} & \text{indicative} \\ \text{AKT} & \text{atelic} \\ \text{SUBCAT} & \langle \text{PP}_{on} \rangle \end{bmatrix} \end{bmatrix}$$

First, note the redundancy between the entries (131-132). More importantly, however, note the similarity in meanings between (133).

(133) a. Cicero commented that Catiline was conspiring.

b. Cicero commented on the Catilinarian conspiracy.

With an alternating verb like *comment*, there is little apparent difference between relationship the verb has with the CP and the one it has with the PP. In both cases, the postverbal constituent is specifying something that *Cicero* made comments about. The syntactic difference entails certain other differences, but it is not apparent that there is anything else fundamentally different about the alternation.

Much the same can be said for many other alternating verbs. Recall again the case of PP/DO source verbs like *escape/depart/flee (from)* and so on. There is only a minimal difference - if any - between the presence of the preposition and its absence. Alternating verbs also like *kick*, where the preposition realizes some morphosyntactic property, see only a minor difference (corresponding to the meaning of the preposition).

These examples and more undermine the need for two distinct lexical entries. To capture the facts of alternating verbs, all that is needed is a representation like (134). The lexical entry of *comment* relates *comment* to its possible dependents, such that there is only one feature matrix for *comment* and both dependents are listed along with it.

(134)

$$\begin{bmatrix} \textit{comment} & & \\ \textsc{copy-index} & \textcircled{1}\,\textcircled{2} & \\ \text{comment} & \begin{bmatrix} \textsc{cat} & \text{verb} \\ \textsc{tense} & \text{pres} \\ \textsc{voice} & \text{active} \\ \textsc{mood} & \text{indicative} \\ \textsc{tel} & \text{telic} \end{bmatrix} \\ \text{P}_{\emptyset} & \begin{bmatrix} \textsc{cat} & \text{P} \\ \textsc{subcat} & \langle \text{CP} \rangle \\ \theta & \\ \textsc{case} & \\ \textsc{index} & \textcircled{2} \end{bmatrix} \\ \text{on} & \begin{bmatrix} \textsc{cat} & \text{prep} \\ \textsc{subcat} & \langle \text{NP} \rangle \\ \theta & \textsc{theme} \\ \textsc{case} & [\textsc{acc}] \\ \textsc{index} & \textcircled{2} \end{bmatrix} \end{bmatrix}$$

With (129) in hand, the complementary distribution of the variants can be captured by manipulating the mechanics of the COPY-INDEX. In Chapter 4, I proposed that both lexical items in a complex lexical entry were copied in to the numeration according to the following mechanism.

> NUMERATION COPY: Copy the feature matrix with index i into the numeration.

In (129), both potential dependents bear the same copy-index. A slight modification to the operation will ensure that only one appears in the numeration.

> NUMERATION COPY (REVISED): Copy one and only one feature matrix with index i into the numeration if $i \in$ I, where I is the set specified by an entry's COPY-INDEX.

For transitive, exotransitive and obligatory verbs, there is a one-to-one mapping between indices and feature bundles in the entry. Therefore, this revision to Numeration Copy changes nothing. For alternating verbs,

however, this means that only one of the two possibilities will be manifest. In this way, the same machinery that accounted for exotransitive verbs can be used to account for obligatory and alternating verbs.

Regarding the structure of alternating verbs, it is the same as the generalized transitive structure (125), at least in the case of PP/DO alternating verbs. In that case, nothing changes structurally at all. The only thing that changes between the two manifestations of PP/DO alternating verbs is the head that licenses the internal argument. For PP/$\emptyset$ alternating verbs, nothing much changes about the structure, either. If the PP is realized, it occurs in the same location as (125). PP/CP alternating verbs can be seen the same way, as long as it is presumed that, like internal arguments, their occurrence is licensed by a null preposition. In each of these manifestations, the arguments are linked to the verb in the same manner as (exo)transitives.

7.3.1.3 Adjuncts

The preceding discussions of obligatory and alternating verbs bring together the lexical, syntactic, and semantic aspects of argument prepositions. But as has been mentioned several times to this point, prepositions are also common as adjuncts. Importantly, nothing that has been said about prepositions as arguments presupposes a distinction between prepositions as arguments and prepositions as adjuncts from the point of view of the prepositions themselves. What differences there are correlate with the structural difference, but there is no reason to suppose that there is anything different about the preposition itself when it occurs as an argument versus when it occurs as an adjunct. Particular prepositions license arguments when they appear to realize a morphosyntactic or semantic property for verbs. Outside of that, there is no clear line to draw between the syntax and semantics of argument and adjunct prepositions. This means that what differences do exist need to be explained, and their similarities need to be incorporated. In this section, the place of adjuncts is discussed.

While useful for understanding the interactions between verbs and argument prepositions, the proposition that prepositions are part of the valence system (supported by the experiment in Chapter 6) does not help in understanding cases where PPs do not interact with verbal valence, like adjunct PPs. In the following examples, the PPs are classic adjuncts: temporals, benefactives, and locatives[2]. They are not necessary for the meaning of the verb that any of them appear with, and the valence of the verb is unaffected by their presence or absence.

(135) a. That shop sells apples (in the autumn). (Temporal)

b. They all stopped what they were doing to locate the missing piece (for Joe). (Benefactive)

[2]With verbs that specify no motion, which is relevant, as will be seen.

c. The obelisk stood (on the platform). (Locative)

These cases pass certain tests for adjuncthood. For one, they can be iterated:

(136) a. That shop sells apples (in the autumn) (during its opening hours).

b. They all stopped what they were doing to locate the missing piece (for Joe) (on behalf of the management).

c. The obelisk stood (on the platform) (amid the crowd of onlookers).

The VPs can also be fronted without them.

(137) a. It was sell apples that that shop did in the autumn.

b. It was stop what they were doing to locate the missing piece that they did for Joe.

c. It was stand that the obelisk did on the platform.

Emphasizing the argument licensing function of prepositions does not add to the understanding of adjuncts, since they pass tests for adjuncthood. As adjuncts, then, they are by definition not interacting with the valence system.

This picture is a bit too narrow, however. Certain classes of PPs appear more frequently as adjuncts than arguments. Temporal and benefactive PPs are good examples, but other PPs are variable. In the examples below, I have juxtaposed sentences with locatives, instrumentals, comitatives as adjuncts against ones where they are arguments.

(138) a. The group stood in the park. (adjunct locative)

b. The group walked in the park. (argument locative)

c. The campers saw the deer with the flashlight. (adjunct instrumental)

d. The campers broke the vase with the flashlight. (argument instrumental)

e. The players arrived with the coach. (adjunct comitative)

f. The players conferred with the coach. (argument comitative)

In terms of well-formedness, there is no contrast in (138). They are nonetheless quite different when put under scrutiny. In Schumacher and Yoshida (submitted), I argued that the argument/adjunct status of PPs of these semantic categories (locative, instrumental, comitative) varied according to the semantic class of the verb they co-occurred with.

By way of illustration, consider the motion verbs in (139-140). Motion verbs can always appear with directional PPs (139), and when they do, the directional PPs are arguments (140). This is demonstrated by using the pseudoclefting test.

(139) The group walked/wandered/sauntered/crawled/jogged into/across/through/past the park.

(140) * What the group did into/across/through/past the park was walk/wander/saunter/crawl/jog.

On the other hand, a PP of an irrelevant type like instrumentals remain adjuncts in both cases.

(141) The group walked/wandered/sauntered/crawled/jogged with their shopping bags.

(142) What the group did with their shopping bags was walk/wander/saunter/crawl/jog.

The case of motion verbs and directional prepositions is a case of a *general* relationship that verbs of a semantic type (motion) have with prepositions of another semantic type (location). No specific lexical subcategorization relation holds between them, and yet, the preposition is licensing an argument for the verb. Motion verbs and directional prepositions are a case in which a preposition type is consistently an argument with a particular class of verbs. However, locational/directional prepositions have a wider distribution than just motion verbs, meaning that while they occur as arguments with the class of motion verbs, they will appear as adjuncts more frequently than as arguments given the large number of verb classes they can appear with. But importantly, it does not make sense to call all locational/directional prepositions adjuncts. The argument/adjunct status of a preposition is determined by what meanings the preposition realizes in combination with the verb, just as it does with exotransitive/alternating/obligatory verbs.

Motion verbs with locative PPs are not the only case like this. Further examples abound: instrumental PPs are arguments with instrumental alternation verbs (143) (Dixon 1991; Levin 1993), comitative PPs with reciprocal verbs (144) (discontinuous reciprocals), and even benefactives with benefactive alternation verbs (145). The evidence that these are arguments is available from their participation in their respective argument structure alternations, rather than pseudoclefting.

(143) a. The knife cut/sliced/pricked/scratched the hide.

b. The tanner cut/sliced/pricked/scratched the hide with the knife.

(144) a. The experts conferred/talked/agreed/quarreled/dueled with the consultants

b. The experts and the consultants conferred/talked/agreed/quarreled/dueled

(145) a. Her brother bought/fixed/assembled/painted a bowl of ice cream for her.

b. Her brother bought/fixed/assembled/painted her a bowl of ice cream.

This is by no means an exhaustive list of more general preposition/verb correspondences, but it demonstrates something important. It shows that certain classes of prepositions and certain classes of verbs *can* have general relationships in which the prepositions license arguments for those verbs. It is fair to say, then, that PP types typically classed as adjuncts are still participating in the valence system. However, they only increase the valence in the sense of the number of arguments that the event is interpreted as having if the verb needs realized the category that the preposition realizes. In this way, adjunct prepositions are doing the same thing as argument prepositions with exotransitive, obligatory, and alternating verb types. The preposition in every case is licensing an argument, but they are not syntactically arguments unless they are matched by a requirement on the verb.

There is one exception that needs to be discussed. Temporals seem to always be adjuncts. This is inconsistent with the idea that prepositions always specify arguments for the verb, since temporals would be a case of prepositions which *never* specify an argument. However, there is reason to question whether temporal PPs are in fact PPs, at least in the same way as the other PPs that I have discussed. Temporal PPs are often considered to have the structure in (146), but there is evidence that they actually have the structure in (147).

(146) $[_{PP}$ P $[_{NP}$ N]]

(147) $[_{PP}$ P $[_{AdvP}$ Adv]]

There are several reasons to suppose this. To begin, temporal PPs act far more like fixed expressions than other types of PPs. So, whereas (148a) can have its object substituted by a pronoun *it*, the temporal cannot (while retaining a temporal interpretation). This is true even though both the locative and the temporal are adjuncts in (148) and they both use the same preposition (*in*).

(148) a. The group sat in the park/it. (locative)

b. The group sat in the afternoon/*it. (temporal)

Second, unlike every other preposition type (agentive, instrumental, etc.), they can never be stranded[3].

(149) Who was the train hit by? (agentive)

(150) What did Jaime cut the squid with? (instrumental)

[3]Or at least, I have not yet encountered a well-formed example in many years of looking.

(151) Who did they all eat the meal for? (benefactive)

(152) a. They ate before noon.

b. *What did they eat before?[4]

Finally, there are no exotransitives, alternating verbs, or obligatory verbs which make use of temporal PPs. In other words, they have no functional uses in marking arguments. The only verb I have found which seems to obligatorily use a temporal PP, *date*, does not even use one of the prepositions that form temporal PPs (*at, on, in, before, after, during*). Instead, it uses *to* (153).

(153) The scholar dated the papyrus fragment to/*at the first century.

To underscore the point, it appears that *to* may take temporals which are headed by PPs. This suggests that even with a verb that takes requires some temporal PP (153), the preposition which occurs obligatorily *to* is itself not a temporal preposition. Instead, it takes the temporal PP.

(154) The scholar dated the papyrus fragment to before/after the first century.

Temporals thus have three major differences from other PPs: they cannot have their NP substituted by a pronoun, they cannot be stranded, and they do not have functional uses. Additionally, temporal PPs share certain similarities with temporal adverbs. So, bare NP adverbs like *Tuesday*, or *midday* optionally co-occur with preceding prepositions (Larson 1985).

(155) a. We found the newspaper (on) Tuesday.

b. We found the newspaper (before/after) last week.

Whatever conditions the occurrence of a preceding preposition with otherwise bare NP adverbs, the fact that they do not change in meaning or form in the presence of the preposition suggests that they remain adverbs. Consequently, prepositions in temporal PPs are taking adverbs, not nouns, and so the claims I have made for PPs and nouns do not apply.

If temporal PPs are not relevant, and complex prepositions are excluded then the following generalization can be maintained:

[4]I cannot explain one intriguing fact, which is the possibility of this and other examples when d-linked. For example *What inning did they leave during?* seems to me to be well-formed (although I have received competing judgments), and *inning* is definitely nominal. I do not find the example well-formed without d-linking: **What did they leave during?*. Nevertheless, I speculate that when the complement of a temporal preposition can be interpreted with a durative interpretation, this results in a grammatical illusion. The sentence is not well-formed, but it is easily processed. Another possibility is that d-linking does not involve movement.

(156) All classes of PPs are arguments with at least one class of verb.

I have demonstrated explicitly that locative, benefactive, comitative, and instrumental PPs can be arguments at least some of the time. Recipient PPs (ditransitives), agentive PPs (passives), and experiencer PPs (raising constructions) are uncontroversially arguments in the indicated contexts. Therefore, it appears that (156) may indeed be an accurate generalization.[5]

Given the correctness of (156), the difference between the prepositional object being an argument or not then differs not according to anything the preposition is doing, but according to the way that the verb is interacting with the PP. The interaction comes down to what is specified by the verb's lexical semantics. If the role licensed by the PP is specified by the verb's lexical semantics, it will be syntactically an argument (unless there is a direct object). If it is not, then it will be syntactically an adjunct. Put another way, the preposition always does the same thing: it licenses its complement noun and marks it with a particular role. Whether or not a particular verb demands that role as one of its arguments will determine the structural relationship that the verb has with that PP. In this way, the relationship of prepositions as argument markers - the one proposed to account for exotransitive/alternating/obligatory verbs - is general to all instances in prepositions with verbs, even including adjuncts.

7.3.2 Prepositions in Nominal Contexts

Only the most basic facts concerning prepositions with nouns has been discussed to this point. Two in particular have been noted: the fact that nouns may rather freely occur with pleonastic *of*, and that nominalized exotransitives occur with their associated preposition. The subject of prepositions and nouns is now of interest, given that the topic of prepositions and verbs - in both argument and adjunct cases - has been analyzed at length. Can the contribution of prepositions to verbs be extended or understood in their nominal uses as well?

Consider the contrast between nouns and verbs on the dimensions that have been heretofore relevant: argument licensing and semantic contribution. Unlike verbs, nouns do not require arguments (Higgenbotham 1983, Dowty 1989, Grimshaw 1990, Adger 2012, Donati & Cecchetto 2011). Indeed, there are successful arguments that show that they do not assign theta roles, either (Grimshaw 1990). The main reason to

[5]It is worth noting that the generalization in (156) presupposes that the classes I have used are accurate. There is not space to justify the categories that I have chosen; they are based on the cumulative body of preceding work that is justified based on regularities among prepositional uses. This seems to me to be sufficient grounds for employing them here. That said, there are undoubtedly microvariations of which I am not aware which may prove contrary to (156). About this possibility I have only to say that when and if some counterexample is produced, it is likely that the space of prepositional uses that I am circumscribing with (156) will not be fractured, but only tightened, as I demonstrated in the case of temporal PPs.

suppose that nouns do not require arguments in English is syntactic. Unlike verbs, nouns never take their (putative) complements directly; a preposition is always required.

(157) a. The district attorney asked for the list *(of) names.

b. The king *(of) the foreign dignitaries must be powerful.

The reasoning goes that if nouns really did require arguments, then they would not need the help of pleonastic prepositions to take them. Furthermore, nouns do not require complements in general (157)[6].

(158) a. She bought a book (of poems).

b. The minister demanded a recounting (of all that had happened).

Both of these attributes distinguish nouns from verbs with respect to arguments. The conclusion follows that nouns do not license arguments, and that prepositions (including pleonastic prepositions) are licensing an argument for them, just as they do with verbs.

Semantically, the contrast between the wide distribution of pleonastic *of* and the associated preposition with nominalized exotransitives suggests on the one hand that their semantic contribution is not necessary in all cases, but that it still comes in to play in specific cases. Thus, nominalized exotransitives like in (159) must occur with the same preposition that occurs in verbal exotransitives, while nominalized simple transitives occur with pleonastic *of*.

(159) a. The mob *resorted to* violence.

b. A *resortion to/*of* violence disgraces the cause.

c. The crowd gravitated to the celebrities.

d. Barry observed the *gravitation to/*of* the celebrities.

e. Marcy participated in charitable activities all year.

f. Her teacher praised Marcy's *participation in/*of* charitable activities.

(160) a. The team defeated their rival.

b. The *defeat of* their rival cheered the team up.

c. His family all celebrated his return.

d. A *celebration of* his return awaited him.

e. Everybody remembers the historic march.

[6]Excepting certain cases like classifier-like nouns, like *a bushel of, a sack of* etc.

f. *Remembrance of* the march is important.

If the preceding argumentation about the contribution of the preposition to verbal exotransitives is correct, it stands to reason that prepositions would be doing the same thing semantically with nominal exotransitives as they do for verbal exotransitives.

In broad terms, then, prepositions with nouns appear to be doing the same things that they are doing for verbs. When nouns require arguments, prepositions must license the arguments for them. This suggestion is echoed by many other authors (Grimshaw 1990, Mateu 2002, Kayne 2009, Gallego 2014 *inter alia*), although not with the same mechanics. In terms of causes and consequences, argument licensing prepositions with verbs and nouns are the same. When nouns require arguments and the occurrence of specific morphosyntactic properties (like affectedness or boundedness), specific prepositions surface.

There is one major difference between nouns and verbs in their use of prepositions that must be addressed. Whereas verbs can use null prepositions to take their arguments, nouns never can. Instead, they must use the pleonastic preposition *of*. By analogy, pleonastic *of* is like a nominal null preposition, only that it is overt. The analogy of *of* to argument licensing null prepositions runs deep. Like null prepositions heads with verbs, pleonastic *of*'s function is to license an argument for another head. The null preposition itself is by-and-large semantically inert, unlike the overt varieties that occur with exotransitives. There is syntactic evidence to support this analogy.

Both pleonastic *of* and the particular subcategorized prepositions are equally possible with nominalizations of alternating verbs[7]. The interpretation of the relationship between the noun and the object of the subcategorized preposition is the same as the relationship between the verb and the object of the subcategorized preposition. Similarly, the interpretation of the object of pleonastic *of* corresponds to relationship that the object of the null thematic head has.

(161) a. The confidant indulged in the feast.

b. The confidant indulged his appetite

c. The confidant's indulgence in the feast/of his appetite

(162) a. The district attorney inquired of the defendant...

b. The district attorney inquired into the evidence.

c. The district attorney's inquiry of the defendant/into the evidence

[7]In particular, the subset of alternating verbs that alternate PP/NP. PP/CP and PP/∅ naturally have no corresponding relationship to pleonastic prepositions.

(163) a. The superstar kicked at the ball.

b. The superstar kicked the ball.

c. The superstar's kick at the ball/of the ball

This correspondence cannot be accidental. Nouns use pleonastic *of* in the same environments that verbs use null prepositions. What is to be made of this difference? Why should nouns not be able to use null prepositions as well?

The answer seems to be syntactic rather than semantic. As has long been known (Hawkins 1981; Partee 1997; Lyons 1986), pleonastic *of* and the genitive phrasal clitic *'s* are often interchangeable syntactically[8]. For example, as pointed out by Partee (1997), there are several possible readings of (164).

(164) John's portrait

On one possible reading, the *portrait* depicts *John*. On another, *John* painted the *portrait*. On yet another, the *portrait* belongs to *John*. The first of these readings are also available on the prepositional structure (165a); the second and third are available when *John* has overt genitive case (165b).

(165) a. the portrait of John

b. the portrait of John's

It is also noteworthy that genitive pronouns must occur as the complement of pleonastic *of* for the same meanings as (165b).

(166) the portrait of mine/ours/theirs/hers/his

On the basis of data like (164-166), it is clear that grammatical case marking is different in the nominal domain than it is in the verbal domain. Direct objects in English are uniformly accusative; never genitive. Whereas no English verbs take genitive objects, it seems to be a requirement that English nouns take genitive arguments.[9] It is no big leap then to suppose that the null preposition can only assign accusative case. Since nouns require genitive arguments, an overt pleonastic *of* must occur. This is not dissimilar from Chomsky (1970)'s assertion that pleonastic *of* occurs because the NP argument of a noun requires case. It is different only in fact that *of* occurs because a null preposition head cannot assign the required case.

[8]What discrepancies exist between the two are well-understood by factors like humanness and animacy; and in any case they are not of concern here.

[9]Although clearly a more nuanced view of genitive case is required, since overt marking occurs in (165b) but not (165a).

7.4 A Concluding Note on Prepositions

A complex picture of prepositions emerges from the investigation of verbs with arguments realized with prepositions, particularly the exotransitive verbs. Having laid out the details of an account of these prepositions and their function in the preceding chapters, it is worth taking a moment to consider what prepositions *are* rather than just what they *do*. In the spirit of the categorical and functional inquiries that characterize much of the previous literature's attempt to explain the distribution and significance of prepositions, I will conclude this dissertation by taking up the issues raised in Chapter 3 about the ontology of prepositions. The questions of principle interest were the classification of prepositions categorically (nominal, verbal, or their own) and where they stood on the lexical/functional divide.

In the final counting, these issues are not really separable. If prepositions are in some way either nominal or verbal, then they must clearly be grouped with the functional apparatus of these categories. Their argument marking functional classifies them unambiguously in that way. If, on the other hand, prepositions are their own category, then the question devolves to the complex/simplex distinction, although it could conceivably require more nuance.

What, then, does the preceding analysis of prepositions have to say about these issues? Recall Zwicky's Functional Equivalence Principle, repeated here.

> THE FUNCTIONAL EQUIVALENCE PRINCIPLE:
>
> Everything you can do with adpositions you can do with case inflections, and vice versa.

The Functional Equivalence Principle supposes a relationship between prepositions and nouns wherein prepositions are functional elements corresponding to grammatical cases. Buried beneath the Functional Equivalence Principle is some version of Fillmore's preposition-case equivalence, where prepositions *are* cases at some level of representation. This is distinct from the more Jackendoffian view that I have been using, where prepositions are distinct items with their own syntax and semantics.

It is worth considering what the preceding analysis of prepositions has to say about the preposition-case equivalence and the Functional Equivalence Principle. In contemporary syntactic theory, grammatical case is a (sometimes morphological) reflex of licensing. If prepositions were cases, or at least, performed the same function as cases *a la* Zwicky, then there should be a consistent mapping of prepositions to cases and ultimately to functions.

However, although argument marking and cases often correlate, it is clear that they are not the same thing. In Section 3.3, I showed that the associated preposition of an exotransitive occurs with it when the

exotransitive is nominal(ized), and that the relationship they share in the verbal domain translates in the nominal one. Pleonastic *of* is not possible in such a case.

(167) a. Peter relied on Jane.

b. Peter's reliance on/*of Jane

(168) a. The defendant consented to the confession.

b. The defendant's consent to/*of the confession

The symmetry between the role denoted by the preposition in verbal and nominal forms is important. If prepositions are cases (or perform the same function as cases), then what the data above show is that the argument in both verbal/nominal domains demands a particular prepositionally manifested case. Correspondingly, pleonastic *of* is impossible because it does not mark the appropriate case. On Zwicky and Fillmore's views, this makes sense: prepositions are cases/do the same thing as cases, and so the same case is required across domains. As a result, the same preposition will occur to mark the argument in both instances.

However, as was mentioned above, pleonastic *of* corresponds the DO role with DO/PP alternating verbs.

(169) a. The confidant indulged his appetite.

b. The confidant indulged in the feast.

c. The confidant's indulgence in the feast/of his appetite

According to Zwicky/Fillmore's views, the reason that (169a)'s object is expressed without a preposition is because it has a default structural case that occurs with a theme role. The reason that (169b) has a preposition is because it bears a distinct role that cannot be marked with simple accusative case by hypothesis. Again by hypothesis, accusative case is not a default with nouns, and so the preposition corresponding to accusative case must manifest itself with nouns. But as long as prepositions correspond to cases, then pleonastic *of* should also be well-formed with verbal DOs, contrary to fact.

(170) * The confidant indulged of his appetite.

If *of* is a case, and it is needed with the nominal form, it should at least be possible with the verbal form to do the same work. Since it is not, pleonastic *of* is not a literal case realization. One might say that pleonastic *of* might just be an overt form of accusative case which is allowed to be null in verbal contexts. But if that position is adopted, there is no making sense of *of* when it must occur in alternating verbs. This position requires that (171a) have the equivalent reading to (171b), contrary to fact.

(171) a. Tom read the Vedas.

b. Tom read of the Vedas.

Striking against the Functional Equivalence Principle, there is a contrast between (171a) and (171b). The preposition is doing something (with presumably the same grammatical case) that cannot be done *just* with a case. Thus, there is not a consistent mapping of prepositions to cases to functions belying the Functional Equivalence Principle and the preposition-case equivalence. In sum, the preposition-case equivalence and Functional Equivalence Principle conflate two related but different functions. Prepositions are not cases, but instead argument licensers, which correlate strongly with cases but are not in the end the same thing.

In the absence of a defensible dissenting position, there is every reason to suppose that prepositions are a separate syntactic category. This category, as discussed, is heterogeneous, including both simplex prepositions (*with, at, for, to*) and complex (*according to, in the manner of, except for*) prepositions. As established in Chapter 5, the complex prepositions do not appear to be functional as it is typically understood.

On the other hand, simplex prepositions are surely functional with exotransitives, and their functional nature has been stressed throughout. Even so, they are not semantically inert either. As was established particularly in the case of *gravitate to*, some aspect of the verb's meaning requires *to* to be realized, and it pertains to *to's* particular lexical semantics. So there is a reason that certain prepositions occur with certain exotransitives, and that relates to some content of theirs, whether semantic or morphosyntactic. Consequently, a categorical lexical/functional divide is not useful in the case of exotransitive verbs, and verbs with argument prepositions more broadly. It is therefore unlikely to be useful broadly in understanding prepositions. If prepositions are not exclusively functional in exotransitives - when their lexicality is least apparent - then it follows *a fortiori* that they are not ever exclusively functional. Undoubtedly, some instances of prepositions are overtly functional. Pleonastic *of* remains, as it has since *Remarks on Nominalization*, the strongest case of purely functional prepositions. But they are also sometimes evidently only lexical as in the case of complex prepositions. Taking it all together, the best characterization of prepositions is that they are functional elements with semantic content. Although it is often supposed that functional categories really have almost no semantic content apart from the morphosyntactic feature(s) that they realize (e.g, future auxiliaries realizing the future tense), there is no reason *a priori* that prepositions cannot have both semantic content and functional uses.

In the final counting, then, prepositions are a distinct and heterogeneous syntactic category, containing argument licensing simplex prepositions, and semantically detailed complex prepositions. The simplex prepositions license arguments in the syntax, and evaluate to thematic predicates at the syntax-semantics

interface. They bear certain meanings, some which correspond to morphosyntactic categories, which they realize when they occur.

7.5 Summary

This chapter began by laying out a complete theory of exotransitive verbs along all relevant dimensions of the grammar: in the lexicon, morphology, syntax and semantics. The theory was extended to other cases of verbs and argument prepositions (obligatory, alternating verbs), then to prepositions heading adjuncts, and finally to nominal cases. The chapter concluded with remarks on the category and functional status of prepositions, with the conclusion being that prepositions are a distinct syntactic category, some of which occur in functional roles, but which also have semantic content.

CHAPTER 8

Conclusion

The focal point of this dissertation has been exotransitive verbs. The corpus study on English verb-preposition collocations leaves no doubt that they not only exist as a class synchronically but that they are easily differentiated from other types of verb-preposition collocations and simple transitives. They are also not assimilatable to any extant theoretical machinery.

Taking their existence as a starting point, then, I used them and their properties to gain deeper insight into the nature of transitivity and prepositions in English. But at the same time, I have never really separated the discussion from several larger themes. How are verbs related to their arguments? What role do prepositions play overall in taking arguments? How should transitivity be conceived, such that prepositional exponence can be included?

In the end, I pursued a theory of transitivity in which verbs do not license their internal arguments. It was that critical feature which allowed for the unification of exotransitives and simple transitives. Critically, in the exo-skeletal framework, prepositions are seen as instantiations of the functional structure which both licenses arguments in the syntax and introduces them at the syntax-semantics interface. The lexicon had to be enriched to accomplish this, such that both exotransitives and simple transitives are associated with the functional head that licenses their internal argument. Both prepositions and these functional heads evaluate to thematic predicates at the syntax-semantics interface. Nevertheless, the enrichment of the lexicon was warranted, as demonstrated by the sentence processing experiments in Chapter 4.

Chapter 6 also provided a significant finding towards understanding *why* prepositions are so involved in transitivity in English. English speakers implicitly associate them with transitivity, especially in contrast to intransitivity. Indeed, learners eschewed reliable statistical cues for associating prepositions with intransitivity in order to produce a system where prepositions aid in the marking of transitivity. When placed in the current literature on artificial language learning and the influence of language-specific constraints on learning, this is a particularly strong example of asymmetric generalization. It establishes the operation of a bias in favor of abstractly associating prepositions with transitivity.

This finding in conjunction with the analysis of exotransitives I proposed has more profound effects on

the conception of prepositions. The received understanding of prepositions is truly as cacophonous as it was portrayed in Chapter 3. The resultant picture here, though, is complete (if not simple). Prepositions are a heterogenous class of words which take obligatory nominal complements. On the one hand are the complex prepositions, which are relational, lexical terms. On the other are simplex prepositions. Simplex prepositions assign license NPs and assign them theta roles. The structural relationship they bear to a VP or NP depends on how peripheral they are to the meaning of the verb.

The theory of transitivity that I have advanced and the better understanding of prepositions I have proposed opens some doors that were previously opaque. There is much potential here for fruitful investigation of the specific syntax and semantics argument structure alternations. There are also available avenues for explaining the peculiarities of prepositional syntax and semantics. It just remains for the work to be done.

In the final counting, I hope to have - at minimum - demonstrated that prepositions are active and critical players in transitivity. Whether the solutions I have offered withstand long term scrutiny is another matter. In any case, I, like everyone else, depend on future work to validate or reject even the most basic conclusion.

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Appendix D: Experiment 1 Stimuli

1.

a) The deal which the investigator tampered in the famous bank flagrantly with violated several laws.

b) The deal with which the investigator tampered in the famous bank flagrantly violated several laws.

c) The deal which the investigator tampered with the famous bank flagrantly in violated several laws.

d) The deal in which the investigator tampered with the famous bank flagrantly violated several laws.

2.

a) The lobby which the representative pandered for her home district fervidly to was quite pleased.

b) The lobby to which the representative pandered for her home district fervidly was quite pleased.

c) The lobby which the representative pandered to her home district fervidly for was quite pleased.

d) The lobby for which the representative pandered to her home district fervidly was quite pleased.

3.

a) The jury which the judge marveled with the nervous defendant often at adjourned to deliberate.

b) The jury at which the judge marveled with the nervous defendant often adjourned to deliberate.

c) The jury which the judge marveled at the nervous defendant often with adjourned to deliberate.

d) The jury with which the judge marveled at the nervous defendant often adjourned to deliberate.

4.

a) The sign which the sightseer gaped beside the big skyscraper stupidly at advertised nice perfume.

b) The sign at which the sightseer gaped beside the big skyscraper stupidly advertised nice perfume.

c) The sign which the sightseer gaped at the big skyscraper stupidly beside advertised nice perfume.

d) The sign beside which the sightseer gaped at the big skyscraper stupidly advertised nice perfume.

5.

a) The limericks which the anthology lapsed after some awkward prose swiftly into were amateur artistry.

b) The limericks into which the anthology lapsed after some awkward prose swiftly were amateur artistry.

c) The limericks which the anthology lapsed into some awkward prose swiftly after were amateur artistry.

d) The limericks after which the anthology lapsed into some awkward prose swiftly were amateur artistry.

6.

a) The official which the spy masqueraded with a close conspirator badly as was promptly questioned.

b) The official as which the spy masqueraded with a close conspirator badly was promptly questioned.

c) The official which the spy masqueraded as a close conspirator badly with was promptly questioned.

d) The official with which the spy masqueraded as a close conspirator badly was promptly questioned.

7.

a) The nation which the machinist emigrated across the rugged country wearily to offered high wages.

b) The nation to which the machinist emigrated across the rugged country wearily offered high wages.

c) The nation which the machinist emigrated to the rugged country wearily across offered high wages.

d) The nation across which the machinist emigrated to the rugged country wearily offered high wages.

8.

a) The vote which the committee assented with the urgent motion slowly to was passed unanimously.

b) The vote to which the committee assented with the urgent motion slowly was passed unanimously.

c) The vote which the committee assented to the urgent motion slowly with was passed unanimously.

d) The vote with which the committee assented to the urgent motion slowly was passed unanimously.

9.

a) The merchandise which the corporation capitalized with the animated movie easily on sold very well.

b) The merchandise on which the corporation capitalized with the animated movie easily sold very well.

c) The merchandise which the corporation capitalized on the animated movie easily with sold very well.

d) The merchandise with which the corporation capitalized on the animated movie easily sold very well.

10.

a) The campaign which the detective snooped for the rival party discreetly on was judged innocent.

b) The campaign on which the detective snooped for the rival party discreetly was judged innocent.

c) The campaign which the detective snooped on the rival party discreetly for was judged innocent.

d) The campaign for which the detective snooped on the rival party discreetly was judged innocent.

11.

a) The matter which the organization reneged over the abrupt mandate openly on never got resolved.

b) The matter on which the organization reneged over the abrupt mandate openly never got resolved.

c) The matter which the organization reneged on the abrupt mandate openly over never got resolved.

d) The matter over which the organization reneged on the abrupt mandate openly never got resolved.

12.

a) The wine which the vacationers reveled after the gourmet food merrily in came from France.

b) The wine in which the vacationers reveled after the gourmet food merrily came from France.

c) The wine which the vacationers reveled in the gourmet food merrily after came from France.

d) The wine after which the vacationers reveled in the gourmet food merrily came from France.

13.

a) The ritual which the foreigners partook of the prayer service freely through was very intricate.

b) The ritual through which the foreigners partook of the prayer service freely was very intricate.

c) The ritual which the foreigners partook through the prayer service freely of was very intricate.

d) The ritual of which the foreigners partook through the prayer service freely was very intricate.

14.

a) The apartment which the author resided beneath a nice penthouse comfortably in was well furnished.

b) The apartment in which the author resided beneath a nice penthouse comfortably was well furnished.

c) The apartment which the author resided in a nice penthouse comfortably beneath was well furnished.

d) The apartment beneath which the author resided in a nice penthouse comfortably was well furnished.

15.

a) The proclamation which the dissenters reacted with a fierce demonstration angrily to offended the citizenry.

b) The proclamation to which the dissenters reacted with a fierce demonstration angrily offended the citizenry.

c) The proclamation which the dissenters reacted to a fierce demonstration angrily with offended the citizenry.

d) The proclamation with which the dissenters reacted to a fierce demonstration angrily offended the citizenry.

16.

a) The kitchen which the inspector barged from the dining area quickly into needed some cleaning.

b) The kitchen into which the inspector barged from the dining area quickly needed some cleaning.

c) The kitchen which the inspector barged into the dining area quickly from needed some cleaning.

d) The kitchen from which the inspector barged into the dining area quickly needed some cleaning.

17.

a) The crater which the scientists delved toward the broad pit cautiously into had mineral deposits.

b) The crater into which the scientists delved toward the broad pit cautiously had mineral deposits.

c) The crater which the scientists delved into the broad pit cautiously toward had mineral deposits.

d) The crater toward which the scientists delved into the broad pit cautiously had mineral deposits.

18.

a) The formation which the general relied against the new tactic recklessly upon won many battles.

b) The formation upon which the general relied against the new tactic recklessly won many battles.

c) The formation which the general relied upon the new tactic recklessly against won many battles.

d) The formation against which the general relied upon the new tactic recklessly won many battles.

19.

a) The forest which the philosopher communed with his tranquil soul deeply in was exceedingly old.

b) The forest in which the philosopher communed with his tranquil soul deeply was exceedingly old.

c) The forest which the philosopher communed in his tranquil soul deeply with was exceedingly old.

d) The forest with which the philosopher communed in his tranquil soul deeply was exceedingly old.

20.

a) The villa which the gentleman presided from the sizable estate firmly over spanned many acres.

b) The villa over which the gentleman presided from the sizable estate firmly spanned many acres.

c) The villa which the gentleman presided over the sizable estate firmly from spanned many acres.

d) The villa from which the gentleman presided over the sizable estate firmly spanned many acres.

21.

a) The country which the outage interfered across the holiday period severely with had poor infrastructure.

b) The country with which the outage interfered across the holiday period severely had poor infrastructure.

c) The country which the outage interfered with the holiday period severely across had poor infrastructure.

d) The country across which the outage interfered with the holiday period severely had poor infrastructure.

22.

a) The performance which the reviewer depended after a short assessment blindly on did not impress.

b) The performance on which the reviewer depended after a short assessment blindly did not impress.

c) The performance which the reviewer depended on a short assessment blindly after did not impress.

d) The performance after which the reviewer depended on a short assessment blindly did not impress.

23.

a) The insects which the animal preyed over most other quarry uniquely upon live under logs.

b) The insects upon which the animal preyed over most other quarry uniquely live under logs.

c) The insects which the animal preyed upon most other quarry uniquely over live under logs.

d) The insects over which the animal preyed upon most other quarry uniquely live under logs.

24.

a) The procedure which the crowd participated through the voter enrollment gladly in was famously efficient.

b) The procedure in which the crowd participated through the voter enrollment gladly was famously efficient.

c) The procedure which the crowd participated in the voter enrollment gladly through was famously efficient.

d) The procedure through which the crowd participated in the voter enrollment gladly was famously efficient.

Appendix E: Experiment 2 Stimuli

1.

a) The deal which the investigator tampered with quite flagrantly in the famous bank violated several laws.

b) The deal with which the investigator tampered quite flagrantly in the famous bank violated several laws.

c) The deal which the investigator tampered in quite flagrantly with the famous bank violated several laws.

d) The deal in which the investigator tampered quite flagrantly with the famous bank violated several laws.

2.

a) The lobby to which the representative pandered particularly fervidly for her home district was quite pleased.

b) The lobby which the representative pandered to particularly fervidly for her home district was quite pleased.

c) The lobby which the representative pandered for particularly fervidly to her home district was quite pleased.

d) The lobby for which the representative pandered particularly fervidly to her home district was quite pleased.

3.

a) The jury which the judge marveled at extremely often with the nervous defendant adjourned to deliberate.

b) The jury at which the judge marveled extremely often with the nervous defendant adjourned to deliberate.

c) The jury which the judge marveled with extremely often at the nervous defendant adjourned to deliberate.

d) The jury with which the judge marveled extremely often at the nervous defendant adjourned to deliberate.

4.

a) The sign which the sightseer gaped at really stupidly beside the big skyscraper advertised nice perfume.

b) The sign at which the sightseer gaped really stupidly beside the big skyscraper advertised nice perfume.

c) The sign which the sightseer gaped beside really stupidly at the big skyscraper advertised nice perfume.

d) The sign beside which the sightseer gaped really stupidly at the big skyscraper advertised nice perfume.

5.

a) The limericks which the anthology lapsed into remarkably swiftly after some awkward prose were amateur artistry.

b) The limericks into which the anthology lapsed remarkably swiftly after some awkward prose were amateur artistry.

c) The limericks which the anthology lapsed after remarkably swiftly into some awkward prose were amateur artistry.

d) The limericks after which the anthology lapsed remarkably swiftly into some awkward prose were amateur artistry.

6.

a) The official which the spy masqueraded as conspicuously badly with a close conspirator was promptly questioned.

b) The official as which the spy masqueraded conspicuously badly with a close conspirator was promptly questioned.

c) The official which the spy masqueraded with conspicuously badly as a close conspirator was promptly questioned.

d) The official with which the spy masqueraded conspicuously badly as a close conspirator was promptly questioned.

7.

a) The nation which the machinist emigrated to awfully wearily across the rugged country offered high wages.

b) The nation to which the machinist emigrated awfully wearily across the rugged country offered high wages.

c) The nation which the machinist emigrated across awfully wearily to the rugged country offered high wages.

d) The nation across which the machinist emigrated awfully wearily to the rugged country offered high wages.

8.

a) The vote which the committee assented to painfully slowly with the urgent motion was passed unani-

mously.

b) The vote to which the committee assented painfully slowly with the urgent motion was passed unanimously.

c) The vote which the committee assented with painfully slowly to the urgent motion was passed unanimously.

d) The vote with which the committee assented painfully slowly to the urgent motion was passed unanimously.

9.

a) The merchandise which the corporation capitalized on incredibly easily with the animated movie sold very well.

b) The merchandise on which the corporation capitalized incredibly easily with the animated movie sold very well.

c) The merchandise which the corporation capitalized with incredibly easily on the animated movie sold very well.

d) The merchandise with which the corporation capitalized incredibly easily on the animated movie sold very well.

10.

a) The campaign which the detective snooped on hardly discreetly for the rival party was judged innocent.

b) The campaign on which the detective snooped hardly discreetly for the rival party was judged innocent.

c) The campaign which the detective snooped for hardly discreetly on the rival party was judged innocent.

d) The campaign for which the detective snooped hardly discreetly on the rival party was judged innocent.

11.

a) The matter which the organization reneged on remarkably openly over the abrupt mandate never got resolved.

b) The matter on which the organization reneged remarkably openly over the abrupt mandate never got resolved.

c) The matter which the organization reneged over remarkably openly on the abrupt mandate never got resolved.

d) The matter over which the organization reneged remarkably openly on the abrupt mandate never got resolved.

12.

a) The wine which the vacationers reveled in exceedingly merrily after the gourmet food came from France.

b) The wine in which the vacationers reveled exceedingly merrily after the gourmet food came from France.

c) The wine which the vacationers reveled after exceedingly merrily in the gourmet food came from France.

d) The wine after which the vacationers reveled exceedingly merrily in the gourmet food came from France.

13.

a) The ritual which the foreigners partook through absolutely freely of the prayer service was very intricate.

b) The ritual through which the foreigners partook absolutely freely of the prayer service was very intricate.

c) The ritual which the foreigners partook of absolutely freely through the prayer service was very intricate.

d) The ritual of which the foreigners partook absolutely freely through the prayer service was very intricate.

14.

a) The apartment which the author resided in very comfortably beneath a nice penthouse was well furnished.

b) The apartment in which the author resided very comfortably beneath a nice penthouse was well furnished.

c) The apartment which the author resided beneath very comfortably in a nice penthouse was well furnished.

d) The apartment beneath which the author resided very comfortably in a nice penthouse was well furnished.

15.

a) The proclamation which the dissenters reacted to genuinely angrily with a fierce demonstration offended the citizenry.

b) The proclamation to which the dissenters reacted genuinely angrily with a fierce demonstration offended the citizenry.

c) The proclamation which the dissenters reacted with genuinely angrily to a fierce demonstration offended the citizenry.

d) The proclamation with which the dissenters reacted genuinely angrily to a fierce demonstration offended the citizenry.

16.

a) The kitchen which the inspector barged into terribly quickly from the dining area needed some cleaning.

b) The kitchen into which the inspector barged terribly quickly from the dining area needed some cleaning.

c) The kitchen which the inspector barged from terribly quickly into the dining area needed some cleaning.

d) The kitchen from which the inspector barged terribly quickly into the dining area needed some cleaning.

17.

a) The crater which the scientists delved into hardly cautiously toward the broad pit had mineral deposits.

b) The crater into which the scientists delved hardly cautiously toward the broad pit had mineral deposits.

c) The crater which the scientists delved toward hardly cautiously into the broad pit had mineral deposits.

d) The crater toward which the scientists delved hardly cautiously into the broad pit had mineral deposits.

18.

a) The formation which the general relied upon somewhat recklessly against the new tactic won many battles.

b) The formation upon which the general relied somewhat recklessly against the new tactic won many battles.

c) The formation which the general relied against somewhat recklessly upon the new tactic won many battles.

d) The formation against which the general relied somewhat recklessly upon the new tactic won many battles.

19.

a) The forest which the philosopher communed with fairly deeply in his tranquil soul was exceedingly old.

b) The forest with which the philosopher communed fairly deeply in his tranquil soul was exceedingly old.

c) The forest which the philosopher communed in fairly deeply with his tranquil soul was exceedingly old.

d) The forest in which the philosopher communed fairly deeply with his tranquil soul was exceedingly old.

20.

a) The villa which the gentleman presided over reasonably firmly from the sizable estate spanned many acres.

b) The villa over which the gentleman presided reasonably firmly from the sizable estate spanned many acres.

c) The villa which the gentleman presided from reasonably firmly over the sizable estate spanned many acres.

d) The villa from which the gentleman presided reasonably firmly over the sizable estate spanned many acres.

21.

a) The country which the outage interfered with rather severely across the holiday period had poor infrastructure.

b) The country with which the outage interfered rather severely across the holiday period had poor infrastructure.

c) The country which the outage interfered across rather severely with the holiday period had poor infrastructure.

d) The country across which the outage interfered rather severely with the holiday period had poor infrastructure.

22.

a) The performance which the reviewer depended on sometimes blindly after a short assessment did not impress.

b) The performance on which the reviewer depended sometimes blindly after a short assessment did not impress.

c) The performance which the reviewer depended sometimes blindly on a short assessment after did not impress.

d) The performance after which the reviewer depended sometimes blindly on a short assessment did not impress.

23.

a) The insects which the animal preyed upon pretty uniquely over most other quarry live under logs.

b) The insects upon which the animal preyed pretty uniquely over most other quarry live under logs.

c) The insects which the animal preyed over pretty uniquely upon most other quarry live under logs.

d) The insects over which the animal preyed pretty uniquely upon most other quarry live under logs.

24.

a) The procedure which the crowd participated in relatively gladly through the voter enrollment was famously efficient.

b) The procedure in which the crowd participated relatively gladly through the voter enrollment was famously efficient.

c) The procedure which the crowd participated through relatively gladly in the voter enrollment was famously efficient.

d) The procedure through which the crowd participated relatively gladly in the voter enrollment was famously efficient.

Appendix A: Candidate Verbs

Verb	Prepositions	Preposition Occurred	Secondary Preposition	Count	Log Frequency	Type	P Occurrence Rate	Dissociation Rate	Mutual Information
abide	by	220	0	333	-12.72567	exotransitive	0.66066	0.01364	7.19575
abound	in	116	0	388	-12.57281	alternating	0.29897	0.15517	4.23149
account	for	2846	0	3089	-10.49821	exotransitive	0.92133	0.02460	6.89719
ache	for	47	0	386	-12.57798	alternating	0.12176	0.23404	3.97753
adhere	to	473	0	513	-12.29354	exotransitive	0.92203	0.11205	6.67610
admit	to	1140	0	8057	-9.53952	obligatory	0.14149	0.41842	3.97201
aim	at	592	0	4124	-10.20923	obligatory	0.14355	0.32095	4.94505
amount	to	2499	0	2524	-10.70021	exotransitive	0.99010	0.01721	6.77885
appeal	to	1618	0	2607	-10.66786	obligatory	0.62064	0.09703	6.10504
approve	of	392	0	2139	-10.86572	alternating	0.18326	0.00000	2.75395
associate	with	652	0	760	-11.90050	obligatory	0.85789	0.64264	7.18771
attach	to	1101	2	1385	-11.30036	obligatory	0.79639	0.60109	6.46214
attribute	to	734	0	855	-11.78271	obligatory	0.85848	0.76975	6.57307
awake	to	83	0	436	-12.45617	alternating	0.19037	0.31325	4.40007
belong	to	4733	0	5819	-9.86493	exotransitive	0.81337	0.05240	6.49520
bet	on	160	0	1852	-11.00979	obligatory	0.08639	0.44375	4.03929
border	on	133	0	301	-12.82670	alternating	0.44186	0.09774	6.39390
bump	in	16	311	528	-12.26472	alternating	0.61932	0.08257	0.92903
calculate	on	95	0	1840	-11.01629	alternating	0.05163	0.95789	3.29660
care	for	1449	0	5364	-9.94635	alternating	0.27013	0.16287	5.12715
cater	to	63	0	992	-11.63409	alternating	0.06351	0.20635	2.81630
chew	on	92	0	728	-11.94351	alternating	0.12637	0.16304	4.58800
cling	to	999	0	1180	-11.46054	exotransitive	0.84661	0.19119	6.55299
clutch	at	216	0	984	-11.64219	alternating	0.21951	0.18519	5.55780
coincide	with	1333	0	1508	-11.21527	alternating	0.88395	0.06302	7.23088
comment	on	1473	63	3365	-10.41263	alternating	0.45646	0.09440	6.38039
compare	with	2118	0	4572	-10.10611	obligatory	0.46325	0.77243	6.29872
compete	for	788	476	2566	-10.68371	exotransitive	0.49260	0.32278	5.31214
complain	of	513	0	3808	-10.28895	alternating	0.13472	0.00000	2.30996
comply	with	1494	0	1793	-11.04217	exotransitive	0.83324	0.02610	7.14564
conceive	of	237	0	697	-11.98703	alternating	0.34003	0.00000	3.64569
concentrate	on	3835	0	4833	-10.05059	exotransitive	0.79350	0.20209	7.23854
condemn	to	156	0	1345	-11.32966	obligatory	0.11599	0.96795	3.68523
confess	to	362	0	1406	-11.28531	alternating	0.25747	0.23481	4.83568
confide	in	182	0	439	-12.44931	alternating	0.41458	0.07143	4.70314
conform	to	871	0	1141	-11.49415	obligatory	0.76337	0.07118	6.40366
consent	to	229	0	350	-12.67588	exotransitive	0.65429	0.03930	6.18121
consist	of	5176	0	6012	-9.83230	exotransitive	0.86094	0.00000	4.98595
contend	with	246	0	683	-12.00732	alternating	0.36018	0.07317	5.93561
contrast	with	669	0	872	-11.76302	obligatory	0.76720	0.58296	7.02652
contribute	to	3393	0	4639	-10.09156	obligatory	0.73141	0.23224	6.34196
convert	to	591	0	2040	-10.91311	obligatory	0.28971	0.79357	5.00588
cope	with	3718	0	4762	-10.06539	exotransitive	0.78076	0.04922	7.05180
correlate	with	279	6	342	-12.69900	exotransitive	0.83333	0.44561	7.11511
correspond	with	380	1418	1901	-10.98368	exotransitive	0.94582	0.09288	5.08615
culminate	in	664	0	720	-11.95456	exotransitive	0.92222	0.05271	5.85661
dawn	on	166	0	421	-12.49118	alternating	0.39430	0.00602	6.22960
deal	in	1574	0	11937	-9.14642	alternating	0.13186	0.71474	3.05049
decide	on	1138	0	16368	-8.83073	alternating	0.06953	0.30756	3.72593
declare	for	279	0	4189	-10.19360	alternating	0.06660	0.93190	3.10713
defer	to	116	0	326	-12.74692	alternating	0.35583	0.20690	5.30247
depend	on	8460	1422	11123	-9.21704	exotransitive	0.88843	0.12295	7.17742
deposit	in	97	0	404	-12.53240	obligatory	0.24010	0.90722	3.91512
deprive	of	5	0	684	-12.00586	obligatory	0.00731	0.00000	-1.89396
derive	from	1567	0	2046	-10.91017	obligatory	0.76588	0.38417	7.65614
devote	to	1454	1	1573	-11.17307	obligatory	0.92498	0.64330	6.67972
dictate	to	127	0	791	-11.86052	obligatory	0.16056	0.53543	4.15437
differ	from	1311	0	2839	-10.58261	exotransitive	0.46178	0.25019	6.92622
dine	on	55	0	425	-12.48172	alternating	0.12941	0.50909	4.62228
disagree	with	567	0	1214	-11.43214	exotransitive	0.46705	0.07055	6.31049
discriminate	against	179	0	537	-12.24782	alternating	0.33333	0.07263	9.40266
dispense	with	313	0	529	-12.26283	exotransitive	0.59168	0.05751	6.65174
dispose	of	918	0	989	-11.63712	exotransitive	0.92821	0.00000	5.09448
distance	from	298	0	356	-12.65888	obligatory	0.83708	0.99664	7.78437
double	as	122	0	1245	-11.40692	alternating	0.09799	0.18033	5.76939
dwell	in	368	0	498	-12.32321	exotransitive	0.73896	0.17663	5.53698
elaborate	on	107	0	426	-12.47937	alternating	0.25117	0.18692	5.57899
emanate	from	423	0	458	-12.40694	exotransitive	0.92358	0.04728	7.92625
embark	on	766	0	948	-11.67946	alternating	0.80802	0.03003	7.26469

Verb	Prepositions	Preposition Occurred	Secondary Preposition	Count	Log Frequency	Type	P Occurrence Rate	Dissociation Rate	Mutual Information
emigrate	to	190	0	352	-12.67018	exotransitive	0.53977	0.11053	5.90364
enlarge	on	40	0	444	-12.43799	alternating	0.09009	0.35000	4.09975
entitle	to	146	0	389	-12.57023	obligatory	0.37532	0.95890	5.37941
equate	with	294	0	490	-12.33941	alternating	0.60000	0.86735	6.67187
expand	on	157	0	2633	-10.65793	alternating	0.05963	0.37580	3.50436
focus	on	2813	0	3521	-10.36731	obligatory	0.79892	0.27195	7.24836
function	as	310	0	1239	-11.41175	alternating	0.25020	0.06774	7.12174
gaze	at	1221	0	2050	-10.90822	exotransitive	0.59561	0.44717	6.99786
glare	at	715	0	915	-11.71489	exotransitive	0.78142	0.24476	7.38959
grasp	at	51	0	1227	-11.42149	alternating	0.04156	0.50980	3.15693
grumble	about	62	0	371	-12.61761	alternating	0.16712	0.24194	7.07963
guard	against	193	0	795	-11.85547	obligatory	0.24277	0.13472	8.94527
guess	at	166	0	3042	-10.51354	alternating	0.05457	0.31325	3.54966
hail	from	78	0	348	-12.68161	alternating	0.22414	0.17949	5.88340
hint	at	214	0	541	-12.24039	alternating	0.39556	0.10748	6.40741
hurl	at	104	0	438	-12.45159	obligatory	0.23744	0.90385	5.67108
identify	with	854	0	7066	-9.67076	alternating	0.12086	0.57026	4.36025
impose	on	1322	0	3044	-10.51289	obligatory	0.43430	0.86762	6.36899
impress	on	85	0	938	-11.69006	obligatory	0.09062	0.43529	4.10818
improve	on	365	0	7967	-9.55075	alternating	0.04581	0.55068	3.12417
indulge	in	581	0	826	-11.81722	alternating	0.70339	0.09466	5.46582
inform	on	130	0	2899	-10.56169	alternating	0.04484	0.80000	3.09326
inquire	into	0	92	433	-12.46308	alternating	0.21247	0.06522	7.23743
insist	on	1738	0	5985	-9.83680	alternating	0.29039	0.09379	5.78831
insure	against	109	0	428	-12.47469	obligatory	0.25467	0.43119	9.01434
interest	in	95	0	585	-12.16220	obligatory	0.16239	0.97895	3.35098
interfere	with	1023	0	1483	-11.23199	exotransitive	0.68982	0.04301	6.87313
introduce	to	1387	0	7388	-9.62620	obligatory	0.18774	0.96611	4.38000
involve	in	2147	0	14125	-8.97811	obligatory	0.15200	0.98929	3.25557
issue	from	116	0	2924	-10.55311	alternating	0.03967	0.56897	3.38519
kick	at	186	0	2513	-10.70458	alternating	0.07402	0.73118	3.98939
laugh	at	1216	0	8050	-9.54039	alternating	0.15106	0.23602	5.01858
launch	into	0	275	3333	-10.42219	alternating	0.08251	0.49091	5.87277
limit	to	617	0	2137	-10.86666	obligatory	0.28872	0.97083	5.00097
linger	on	160	0	589	-12.15539	alternating	0.27165	0.11250	5.69204
match	with	274	0	3036	-10.51552	obligatory	0.09025	0.91241	3.93892
mention	in	699	0	5508	-9.91986	obligatory	0.12691	0.79971	2.99526
model	on	48	0	372	-12.61492	alternating	0.12903	0.93750	4.61804
negotiate	with	657	0	2138	-10.86619	obligatory	0.30730	0.40944	5.70654
object	to	738	0	1176	-11.46394	exotransitive	0.62755	0.06775	6.12102
occur	to	1309	0	12888	-9.06976	alternating	0.10157	0.36211	3.49372
offend	against	29	0	524	-12.27232	alternating	0.05534	0.06897	6.81218
participate	in	1898	0	2416	-10.74395	exotransitive	0.78560	0.09536	5.62528
permit	of	7	0	2543	-10.69271	alternating	0.00275	0.00000	-3.30300
plunge	in	67	416	804	-11.84421	obligatory	0.60075	0.63147	2.38846
poke	at	99	0	631	-12.08651	alternating	0.15689	0.83838	5.07328
ponder	over	31	0	594	-12.14693	alternating	0.05219	0.06452	6.96741
pose	as	170	0	1871	-10.99959	alternating	0.09086	0.09412	5.66038
preside	over	314	0	463	-12.39609	exotransitive	0.67819	0.01592	10.66729
presume	on	23	0	754	-11.90842	alternating	0.03050	0.73913	2.53738
pretend	to	1053	0	2498	-10.71057	alternating	0.42154	0.05413	5.54695
prevail	upon	0	12	770	-11.88742	alternating	0.01558	0.25000	6.26023
pronounce	on	56	0	650	-12.05684	alternating	0.08615	0.41071	4.03529
protest	against	254	0	1853	-11.00925	alternating	0.13708	0.07087	8.12066
quit	on	28	0	943	-11.68475	alternating	0.02969	0.71429	2.49848
range	from	1957	44	2383	-10.75770	exotransitive	0.83970	0.01649	7.75680
react	to	1068	0	2332	-10.77933	exotransitive	0.45798	0.30618	5.66656
reckon	on	157	0	3393	-10.40434	alternating	0.04627	0.74522	3.13851
reconcile	with	279	0	696	-11.98846	obligatory	0.40086	0.82079	6.09002
refer	to	7809	0	8504	-9.48552	exotransitive	0.91827	0.19145	6.67021
reflect	on	971	130	8663	-9.46700	alternating	0.12709	0.35513	4.41491
refrain	from	393	0	417	-12.50073	exotransitive	0.94245	0.03308	7.95542
relate	to	7078	0	7989	-9.54799	obligatory	0.88597	0.19271	6.61854
relieve	0	0	0	1055	-11.57252	obligatory	0.00000	0.00000	0.00000
rely	on	3688	430	4367	-10.15198	exotransitive	0.94298	0.18456	7.32843
remark	on	116	0	1558	-11.18266	alternating	0.07445	0.25862	3.82474
remind	of	19	0	4348	-10.15634	obligatory	0.00437	0.00000	-2.63625
reside	in	400	0	681	-12.01025	exotransitive	0.58737	0.21500	5.20577

Verb	Prepositions	Preposition Occurred	Secondary Preposition	Count	Log Frequency	Type	P Occurrence Rate	Dissociation Rate	Mutual Information
resort	to	552	0	574	-12.18118	exotransitive	0.96167	0.03261	6.73683
result	in	4659	0	6372	-9.77414	exotransitive	0.73117	0.06053	5.52170
revert	to	618	0	645	-12.06456	exotransitive	0.95814	0.13430	6.73152
rid	of	10	0	349	-12.67874	obligatory	0.02865	0.00000	0.07680
rule	on	153	49	2096	-10.88603	alternating	0.09637	0.38614	3.79620
safeguard	against	41	0	653	-12.05224	alternating	0.06279	0.48780	6.99423
seize	on	120	0	1463	-11.24557	alternating	0.08202	0.45000	3.96441
sip	at	121	0	848	-11.79093	alternating	0.14269	0.45455	4.93637
smack	of	67	0	424	-12.48408	alternating	0.15802	0.00000	2.54013
smile	on	132	0	8575	-9.47721	alternating	0.01539	0.73485	1.55071
snatch	at	71	0	827	-11.81601	alternating	0.08585	0.46479	4.20343
sniff	at	114	0	936	-11.69220	alternating	0.12179	0.37719	4.70795
snort	at	12	0	353	-12.66735	alternating	0.03399	0.75000	2.86686
stare	at	4787	0	7299	-9.63832	exotransitive	0.65584	0.32170	7.13685
stem	from	682	0	958	-11.66897	exotransitive	0.71190	0.15982	7.55068
strive	for	229	0	909	-11.72147	exotransitive	0.25193	0.13100	5.02647
subscribe	to	340	0	523	-12.27423	exotransitive	0.65010	0.12647	6.17194
substitute	for	433	0	853	-11.78505	obligatory	0.50762	0.68822	6.03722
succumb	to	329	0	407	-12.52500	exotransitive	0.80835	0.06687	6.48627
sue	for	527	0	1214	-11.43214	obligatory	0.43410	0.48577	5.81150
suffer	from	2582	0	7671	-9.58861	alternating	0.33659	0.14369	6.47001
surrender	to	269	0	776	-11.87966	obligatory	0.34665	0.58364	5.26477
swear	by	81	0	1535	-11.19753	alternating	0.05277	0.22222	3.54960
testify	to	224	0	509	-12.30137	alternating	0.44008	0.09821	5.60905
thrive	on	204	0	653	-12.05224	alternating	0.31240	0.05392	5.89372
transform	to	115	661	1592	-11.16107	obligatory	0.48744	0.94716	3.00208
translate	to	87	553	1154	-11.48282	obligatory	0.55459	0.75156	3.06373
usher	in	132	0	425	-12.48172	alternating	0.31059	0.13636	4.28650
venture	on	41	0	698	-11.98559	alternating	0.05874	0.56098	3.48270
weigh	against	66	0	1733	-11.07620	alternating	0.03808	0.83333	6.27296
yield	to	235	0	1568	-11.17626	obligatory	0.14987	0.55319	4.05502

Appendix B: Noun Set

Noun	Verb	Preposition	Preposition Occurred	Occurrence Rate	Of Occurred	Of Occurrence Rate	Frequency	Dissociation Rate	Mutual Information
abstention	abstain	from	30	0.09346	2	0.00623	321	0.30000	4.62140
abundance	abound	in	45	0.06798	337	0.50906	662	0.57778	2.09459
accession	accede	to	117	0.20455	164	0.28671	572	0.11111	4.50371
account	account	for	3385	0.16928	6026	0.30135	19997	0.14121	4.45284
ache	ache	for	45	0.07909	37	0.06503	569	0.17778	3.35497
acquaintance	acquaint	with	171	0.19633	68	0.07807	871	0.12281	5.06016
acquiescence	acquiesce	to	18	0.10588	22	0.12941	170	0.44444	3.55375
adherence	adhere	to	335	0.88158	10	0.02632	380	0.02090	6.61138
admission	admit	to	683	0.24117	303	0.10699	2832	0.21376	4.74135
aim	aim	at	689	0.06236	2625	0.23758	11049	0.37591	3.74216
amount	appeal	to	3249	0.18545	10044	0.57329	17520	0.18190	4.36228
approval	approve	of	840	0.21255	0	0	3952	0	2.96784
ascription	ascribe	to	6	0.17143	13	0.37143	35	0.33333	4.24890
assent	assent	to	121	0.27500	46	0.10455	440	0.16529	4.93072
assimilation	assimilate	to	17	0.05743	83	0.28041	296	0.64706	2.67123
association	associate	with	1662	0.12169	1814	0.13282	13658	0.21841	4.37009
atonement	atone	for	28	0.21374	3	0.02290	131	0.21429	4.78933
attribution	attribute	to	35	0.14403	78	0.32099	243	0.20000	3.99769
belonging	belong	to	1	0.50000	0	0	2	0	5.79322
bet	bet	on	272	0.10730	17	0.00671	2535	0.33456	4.35193
border	border	on	352	0.06876	376	0.07345	5119	0.46307	3.71002
bristle	bristle	with	102	0.32692	4	0.01282	312	0.08824	5.79586
budget	budget	for	1056	0.12533	399	0.04735	8426	0.48864	4.01916
burrow	burrow	in	57	0.12667	6	0.01333	450	0.47368	2.99253
calculation	calculate	on	148	0.06655	427	0.19200	2224	0.68919	3.66275
capitulation	capitulate	to	19	0.24675	8	0.10390	77	0.21053	4.77436
care	care	for	2462	0.12197	2057	0.10191	20185	0.35540	3.98002
catering	cater	to	40	0.06410	1	0.00160	624	0.90000	2.82974
co-occurrence	co-occur	with	2	0.06061	4	0.12121	33	0.50000	3.36445
coincidence	coincide	with	24	0.02570	92	0.09850	934	0.66667	2.12652
comment	comment	on	2522	0.26397	170	0.01779	9554	0.12966	5.65070
communion	commune	with	83	0.14092	20	0.03396	589	0.24096	4.58176
comparison	compare	with	1430	0.28761	856	0.17216	4972	0.15455	5.61103
competition	compete	for	924	0.09423	78	0.00795	9806	0.40584	3.60770
complaint	complain	of	233	0.05283	0	0	4410	0	0.95958
compliance	comply	with	625	0.48752	27	0.02106	1282	0.06400	6.37237
comportment	comport	with	1	0.20000	1	0.20000	5	1	5.08691
concentration	concentrate	on	408	0.06942	1792	0.30492	5877	0.21078	3.72380
conception	conceive	of	1438	0.62603	0	0	2297	0	4.52627
condemnation	condemn	to	15	0.03254	244	0.52928	461	0.60000	1.85148
confession	confess	to	78	0.09364	101	0.12125	833	0.52564	3.37645
confidence	confide	in	1924	0.28079	313	0.04568	6852	0.21881	4.14101
confinement	confine	to	23	0.07325	23	0.07325	314	0.39130	3.02216
connivance	connive	at	2	0.04878	23	0.56098	41	0.50000	3.38787
consent	consent	to	644	0.18980	558	0.16446	3393	0.24068	4.39579
consignment	consign	to	24	0.07251	114	0.34441	331	0.66667	3.00749
contention	contend	with	40	0.05450	24	0.03270	734	0.62500	3.21113
contrast	contrast	with	1374	0.19263	89	0.01248	7133	0.43668	5.03271
contribution	contribute	to	3386	0.41901	712	0.08811	8081	0.16834	5.53826
conversion	convert	to	348	0.14702	450	0.19011	2367	0.31034	4.02732
correspondence	correspond	with	231	0.15339	55	0.03652	1506	0.25974	4.70408
culmination	culminate	in	16	0.05298	259	0.85762	302	0.43750	1.73502
dawn	dawn	on	276	0.15393	142	0.07920	1793	0.19928	4.87260
deal	deal	in	1284	0.05881	3199	0.14652	21833	0.47040	1.88563
decision	decide	on	1915	0.08032	1428	0.05990	23841	0.38538	3.93421
declaration	declare	for	99	0.04369	711	0.31377	2266	0.88889	2.49882
dedication	dedicate	to	171	0.26553	97	0.15062	644	0.14035	4.88015
defection	defect	to	29	0.12236	66	0.27848	237	0.31034	3.76245
deference	defer	to	172	0.56766	5	0.01650	303	0.10465	5.97631
degenerate	degenerate	to	6	0.03871	0	0	155	0.50000	2.10205
dependent	depend	on	5	0.04065	11	0.08943	123	0.60000	2.95165
deposit	deposit	in	489	0.14623	338	0.10108	3344	0.69530	3.19975
deprivation	deprive	of	78	0.08914	0	0	875	0	1.71422
derivation	derive	from	23	0.10222	113	0.50222	225	0.21739	4.75072
despair	despair	of	96	0.08326	0	0	1153	0	1.61575
detraction	detract	from	2	0.40000	0	0	5	0	6.71901
deviation	deviate	from	251	0.31026	137	0.16934	809	0.06375	6.35248
dictation	dictate	to	10	0.09009	8	0.07207	111	0.50000	3.32073
difference	differ	from	374	0.01993	723	0.03853	18765	0.56952	2.39207

Noun	Verb	Preposition	Preposition Occurred	Occurrence Rate	Of Occurred	Of Occurrence Rate	Frequency	Dissociation Rate	Mutual Information
dinner	dine	on	250	0.04062	51	0.00829	6155	0.56400	2.95048
disagreement	disagree	with	159	0.13814	7	0.00608	1151	0.23270	4.55305
discourse	discuss	on	123	0.04614	275	0.10315	2666	0.36585	3.13429
dispensation	dispense	with	6	0.03636	17	0.10303	165	0.66667	2.62748
disposal	dispose	of	594	0.26283	0	0	2260	0	3.27417
dissociation	dissociate	from	38	0.17431	44	0.20183	218	0.26316	5.52068
divergence	diverge	from	29	0.08761	80	0.24169	331	0.17241	4.52823
divestment	divest	from	4	0.06250	6	0.09375	64	0.50000	4.04094
dwelling	dwell	in	230	0.18053	39	0.03061	1274	0.58696	3.50376
earmark	earmark	for	23	0.45098	2	0.03922	51	0.91304	5.86653
elaboration	elaborate	on	6	0.01824	168	0.51064	329	0.50000	1.79525
embarkation	embark	on	2	0.04651	3	0.06977	43	0.50000	3.14597
emigrant	emigrate	to	27	0.15976	1	0.00592	169	0.37037	4.14722
encroachment	encroach	on	53	0.25980	40	0.19608	204	0.07547	5.62773
endearment	endear	to	9	0.11392	0	0	79	0.66667	3.65936
endowment	endow	with	19	0.02896	67	0.10213	656	0.84211	2.29922
enlargement	enlarge	on	5	0.01618	171	0.55340	309	1	1.62270
entitlement	entitle	to	320	0.39024	38	0.04634	820	0.11563	5.43566
equation	equate	with	125	0.03601	199	0.05733	3471	0.81600	2.61349
expansion	expand	on	77	0.02168	1260	0.35473	3552	0.76623	2.04461
exultation	exult	in	5	0.08475	6	0.10169	59	0.40000	2.41271
familiarization	familiarize	with	3	0.23077	1	0.07692	13	1	5.29336
flirt	flirt	with	183	0.66065	2	0.00722	277	0.12568	6.81080
focus	focus	on	3363	0.49066	1110	0.16195	6854	0.28903	6.54504
gamble	gamble	on	96	0.20779	20	0.04329	462	0.21875	5.30545
gaze	gaze	at	1271	0.31422	95	0.02349	4045	0.44532	6.07525
glare	glare	at	727	0.54662	172	0.12932	1330	0.24897	6.87402
glory	glory	in	213	0.12241	325	0.18678	1740	0.39906	2.94326
grasp	grasp	at	57	0.02869	400	0.20131	1987	0.56140	2.62194
gravitation	gravitate	to	1	0.01923	0	0	52	0	1.09278
grope	grope	for	96	0.34532	0	0	278	0.26042	5.48142
guess	guess	at	210	0.05995	14	0.00400	3503	0.26190	3.68529
hankering	hanker	after	2	0.25000	0	0	8	0	8.58218
hinge	hinge	on	86	0.22751	10	0.02646	378	0.16279	5.43626
hint	hint	at	243	0.10872	1017	0.45503	2235	0.14403	4.54418
impact	impact	on	2022	0.26810	2729	0.36184	7542	0.12710	5.67307
impingement	impinge	on	1	0.07692	5	0.38462	13	0	3.87180
imposition	impose	on	21	0.02987	568	0.80797	703	0.14286	2.50717
impression	impress	on	347	0.07275	1229	0.25765	4770	0.33718	3.79125
imprint	imprint	on	48	0.16162	87	0.29293	297	0.37500	4.94288
improvement	improve	on	314	0.04826	494	0.07592	6507	0.26433	3.19908
imputation	impute	to	1	0.01587	21	0.33333	63	1	0.81594
inclination	incline	to	213	0.32719	50	0.07680	651	0.11268	5.18141
information	inform	on	3991	0.10569	196	0.00519	37761	0.32273	4.33016
insistence	insist	on	313	0.38834	61	0.07568	806	0.03834	6.20762
insurance	insure	against	148	0.02144	34	0.00493	6903	0.45270	5.44407
interest	interest	in	9884	0.26728	3876	0.10481	36980	0.25617	4.06984
interference	interfere	with	296	0.21098	46	0.03279	1403	0.08446	5.16399
introduction	introduce	to	1090	0.19204	3160	0.55673	5676	0.08440	4.41267
inundation	inundate	with	1	0.04000	5	0.20000	25	1	2.76498
issue	issue	from	552	0.02006	4748	0.17259	27511	0.75543	2.40174
jockey	jockey	for	84	0.09061	10	0.01079	927	0.57143	3.55129
kick	kick	at	244	0.06514	37	0.00988	3746	0.65574	3.80503
latch	latch	on	107	0.34295	15	0.04808	312	0.02804	6.02830
laugh	laugh	at	1234	0.13608	24	0.00265	9068	0.23258	4.86798
limit	limit	to	1270	0.17607	1217	0.16872	7213	0.60079	4.28744
lust	lust	after	24	0.05031	23	0.04822	477	0.08333	6.26930
luxury	luxuriate	in	39	0.05462	218	0.30532	714	0.74359	1.77904
marvel	marvel	at	185	0.50824	34	0.09341	364	0.08649	6.76901
masquerade	masquerade	as	96	0.71642	4	0.02985	134	0.02083	8.63945
match	match	with	595	0.06562	228	0.02515	9067	0.66555	3.47918
meditation	meditate	on	111	0.18910	6	0.01022	587	0.11712	5.16943
mention	mention	in	792	0.11584	877	0.12827	6837	0.73106	2.86363
minor	minor	in	22	0.08240	15	0.05618	267	0.59091	2.37216
model	model	on	538	0.03084	2697	0.15462	17443	0.85130	2.55334
negotiation	negotiate	with	821	0.17339	163	0.03442	4735	0.19610	4.88093
objection	object	to	1017	0.40214	58	0.02293	2529	0.17109	5.47897
occurrence	occur	to	48	0.03590	613	0.45849	1337	0.77083	1.99339
offence	offend	against	226	0.03822	491	0.08304	5913	0.24336	6.27812

Noun	Verb	Preposition	Preposition Occurred	Occurrence Rate	Of Occurred	Of Occurrence Rate	Frequency	Dissociation Rate	Mutual Information
parley	parley	with	11	0.47826	0	0	23	0.36364	6.34471
participation	participate	in	1168	0.44192	307	0.11616	2643	0.16610	4.79529
permission	permit	of	187	0.05674	0	0	3296	0	1.06235
piggyback	piggyback	on	10	0.32258	0	0	31	0.20000	5.93997
pontification	pontificate	on	1	0.20000	1	0.20000	5	0	5.25031
posture	posture	as	20	0.03110	66	0.10264	643	0.35000	4.11383
pounce	pounce	on	134	0.47350	1	0.00353	283	0.03731	6.49367
predisposition	predispose	to	68	0.46897	7	0.04828	145	0.07353	5.70077
preface	preface	with	37	0.08043	17	0.03696	460	0.94595	3.77280
presumption	presume	on	7	0.01323	93	0.17580	529	0.71429	1.33247
pretender	pretend	to	34	0.32381	1	0.00952	105	0.29412	5.16643
prey	prey	on	88	0.05962	17	0.01152	1476	0.38636	3.50419
pronouncement	pronounce	on	47	0.15016	43	0.13738	313	0.23404	4.83681
quarrel	quarrel	with	241	0.29426	12	0.01465	819	0.14523	5.64401
rat	rat	on	71	0.03029	13	0.00555	2344	0.67606	2.52723
reaction	react	to	1828	0.24894	501	0.06823	7343	0.16466	4.78711
rebound	rebound	on	23	0.10550	3	0.01376	218	0.21739	4.32761
reconciliation	reconcile	with	74	0.09973	71	0.09569	742	0.33784	4.08302
recuperation	recuperate	from	2	0.05128	3	0.07692	39	0.50000	3.75553
reflection	reflect	on	320	0.13317	747	0.31086	2403	0.08750	4.66354
refrain	refrain	from	393	0.77668	13	0.02569	506	0.03308	7.67633
regression	regress	to	55	0.07937	50	0.07215	693	0.52727	3.13786
relation	relate	to	5827	0.32399	899	0.04999	17985	0.08032	5.16725
reliance	rely	on	619	0.71810	31	0.03596	862	0.10824	7.09449
relief	relieve	of	303	0.04637	0	0	6534	0	0.77138
reminder	remind	of	535	0.43852	0	0	1220	0	4.01269
residence	reside	in	343	0.18825	143	0.07849	1822	0.41983	3.56418
resonance	resound	with	31	0.07311	51	0.12028	424	0.67742	3.63512
result	result	in	7056	0.18974	11746	0.31586	37187	0.28671	3.57555
reveller	revel	in	14	0.13861	2	0.01980	101	0.42857	3.12257
reversion	revert	to	97	0.39271	28	0.11336	247	0.09278	5.44476
riddle	riddle	with	44	0.18257	43	0.17842	241	0.18182	4.95538
rule	rule	on	747	0.03925	2462	0.12936	19032	0.60241	2.90106
rumination	ruminate	on	3	0.21429	3	0.21429	14	0	5.34984
safeguard	safeguard	against	126	0.10615	25	0.02106	1187	0.18254	7.75180
secession	seccede	from	47	0.20435	28	0.12174	230	0.17021	5.75004
seizure	seize	on	20	0.03861	231	0.44595	518	0.55000	2.87735
smear	smear	on	41	0.09903	66	0.15942	414	0.63415	4.23630
smile	smile	on	546	0.03764	243	0.01675	14504	0.32418	2.84083
snitch	snitch	on	1	0.12500	0	0	8	0	4.57224
spy	spy	on	141	0.13703	8	0.00777	1029	0.24113	4.70476
square	square	with	236	0.07930	345	0.11593	2976	0.63559	3.75232
stare	stare	at	4765	0.63171	40	0.00530	7543	0.31857	7.08276
stem	stem	from	741	0.36467	123	0.06053	2032	0.19028	6.58558
subjection	subject	to	39	0.37143	28	0.26667	105	0.12821	5.36437
subscription	subscribe	to	234	0.20856	38	0.03387	1122	0.35470	4.53172
substitution	substitute	for	64	0.08466	195	0.25794	756	0.39063	3.45316
suffering	suffer	from	36	0.04004	171	0.19021	899	0.41667	3.39868
surrender	surrender	to	315	0.25424	152	0.12268	1239	0.54921	4.81746
testimony	testify	to	283	0.36945	131	0.17102	766	0.12014	5.35667
thirst	thirst	for	82	0.30597	6	0.02239	268	0.06098	5.30686
trafficker	traffic	in	18	0.09524	2	0.01058	189	0.77778	2.58110
trespasser	trespass	on	8	0.05000	1	0.00625	160	0.37500	3.25031
trifle	trifle	with	16	0.05461	6	0.02048	293	0.43750	3.21408
usher	usher	in	134	0.29712	10	0.02217	451	0.14925	4.22253
venture	venture	on	95	0.03261	37	0.01270	2913	0.69474	2.63380
verge	verge	on	111	0.15417	470	0.65278	720	0.08108	4.87480
yearning	yearn	for	12	0.14118	11	0.12941	85	0.08333	4.19097

Appendix C: Synonyms

Simple Transitive	Exotransitive/Obligatory/Alternating	Simple Transitive	Exotransitive/Obligatory/Alternating	Simple Transitive	Exotransitive/Obligatory/Alternating
abandon	despair	demarcate	differ	ogle	gape
abdicate	surrender	deny	debar	operate	function
abut	verge	depart	emigrate	oppose	object
accompany	coincide	design	model	overflow	abound
accredit	entitle	desire	lust	overlap	superimpose
acknowledge	react	detail	elaborate	oversee	preside
adjudicate	negotiate	detain	confine	overstep	encroach
adore	fawn	develop	expand	own	belong
affirm	admit	devise	conceive	pamper	lavish
alienate	dissociate	discard	dispose	parallel	liken
allocate	budget	disclose	confide	peddle	retail
allow	assent	discuss	commune	perforate	riddle
alter	tamper	dispirit	tire	perform	participate
amass	deposit	display	posture	pinch	peck
ambush	pounce	divvy	dispense	pinpoint	focus
amuse	toy	dominate	tower	pitch	hurl
anguish	ache	drag	trawl	placate	reconcile
announce	declare	echo	resonate	please	pander
annoy	nag	educate	dictate	pledge	dedicate
antagonize	offend	emit	issue	promise	swear
ask	inquire	enable	permit	prosecute	sue
assert	testify	encircle	border	prosper	thrive
assuage	relieve	endure	suffer	protest	complain
assure	vouch	enhance	improve	purge	rid
attract	gravitate	enlarge	double	purvey	cater
augment	enlarge	entangle	involve	ransack	rifle
authorize	approve	enternal	whizz	recall	remind
avoid	refrain	entertain	indulge	reconnoiter	spy
await	rely	equal	correspond	redeem	atone
awe	impress	equalize	equate	reference	ascribe
back	side	evade	balk	reiterate	harp
bankrupt	deprive	eventuate	result	relapse	lapse
battle	quarrel	exalt	hail	relinquish	yield
befuddle	puzzle	examine	compare	relish	luxuriate
belittle	scoff	excavate	burrow	renounce	quit
benefit	avail	exist	consist	require	depend
bequeath	endow	exit	stem	resemble	jibe
besmirch	smear	explain	account	resist	militate
bewitch	engross	exploit	capitalize	restrict	limit
bias	predispose	explore	delve	reveal	occur
bite	nibble	expose	rat	ricochet	rebound
bluff	pretend	eye	stare	rouse	awake
boast	glory	eyeball	gaze	sample	partake
boot	kick	fascinate	interest	sanction	consent
bother	intrude	fasten	latch	saturate	immerse
broach	refer	favor	incline	savor	revel
browse	thumb	fight	wrestle	savour	sip
buffet	smack	flatter	dote	scan	browse
bulldoze	barge	ford	wade	scold	rail
calm	lull	forgo	abstain	scrutinize	concentrate
captivate	appeal	fraternize	consort	season	acclimate
capture	glom	frequent	resort	secure	safeguard
castigate	condemn	fret	fuss	seethe	bristle
cavort	playact	frown	glare	separate	secede
censure	impute	fumble	grope	shove	jostle
challenge	vie	genuflect	kowtow	skim	leaf
charm	endear	govern	rule	smoke	reek
cheapen	detract	grin	smile	spare	skimp
chew	gnaw	grind	chew	speculate	bet
chop	hew	grip	clutch	squander	trifle
chuckle	laugh	guarantee	insure	stab	jab
clasp	cling	hack	cleave	stamp	imprint
classify	identify	hammer	ram	steal	snatch
commence	embark	handle	deal	steer	usher
compel	foist	heed	abide	strike	impact
complement	match	hinder	meddle	submerge	wallow
comply	accede	huddle	powwow	subsidize	contribute
concern	pertain	hunt	prey	suggest	mention
conclude	decide	impersonate	masquerade	supplant	substitute
confirm	confess	implant	infuse	supplement	piggyback
conjecture	guess	inform	acquaint	suppose	calculate

Simple Transitive	Exotransitive/Obligatory/Alternating	Simple Transitive	Exotransitive/Obligatory/Alternating	Simple Transitive	Exotransitive/Obligatory/Alternating
conserve	scrimp	inhabit	reside	surmise	presume
consider	weigh	inhale	sniff	synchronise	sync
consolidate	hinge	initiate	launch	tab	earmark
consume	dine	institute	impose	target	aim
contemplate	ponder	intimate	hint	tease	flirt
continue	suffuse	introduce	preface	tell	inform
contract	subscribe	invade	impinge	terminate	culminate
contradict	disagree	jab	poke	tolerate	acquiesce
contravene	contrast	jeopardize	venture	total	amount
contribute	give	link	associate	transition	segue
convalesce	recuperate	lounge	bask	transport	traffic
convince	prevail	lure	ply	try	dabble
corral	grasp	match	comport	uncover	denude
cover	paper	model	pose	unfold	dawn
crave	hanker	modify	convert	unite	dovetail
crouch	stoop	murmur	grumble	violate	infringe
declaim	inveigh	naturalize	familiarize	watch	care
decree	pronounce	navigate	jockey	weave	interlace
default	renege	notify	apprise	wonder	marvel
defraud	welch	nudge	prod	yell	snap
delay	linger	obey	comply		
deliberate	parley	observe	remark		
demand	insist	obstruct	interfere		

Appendix F: Preposition and Meaning Components

Class	Prep	Unanalyzable Component	Prepositional Component	Justification (when applicable)
divest, deprive, denude, dispossess, bereave, rid	of	removal of possession	possession	
encroach, trespass, intrude, infringe, impinge	on	an autonomous domain	bounded plane	
count, depend, rely, hinge	on	contingence (often benefactive)	supporting surface	This is metaphorical extension of a supporting surface to the supporting nature of contingence. The perseverance or continuation of a current state is contingent on some supporting circumstances, which is analogous to a surface that holds something up
concentrate, ruminate, cogitate	on	proposition	surface (a supporting bounded plane)	The proposition is construed as a surface upon which the act of concentration/rumination/cogitation etc., is based on. The whole act of concentration rests upon some particular proposition, with the particular verb specifying the manner in which it occurred. The act builds up upon the proposition; that is, an act of rumination consists of the selection of a proposition and then the layering of thoughts on top of that proposition.
kowtow, succumb, capitulate	to	demand of submission	endpoint	Very similar to the *accede* group, but the nature of the contentious issue has changed from a contentious proposition to a particular kind of contentious proposition, namely the demand for submission.
resort, revert, regress, degenerate	to	prior state	endpoint	
dovetail, correspond, correlate, resonate	with	harmonious relationship	together	
commune, consort, hobnob	with	meeting	together	