

Cognitive State Semantics and Cognitive Transform Grammar: Bridging Formalization and Phenomenology in Linguistic Representations

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Abstract

On connaît la célèbre affirmation de Claude Lévi-Strauss: “les sciences humaines seront structurales ou ne seront pas”. Nous aimerions lui en adjoindre une autre: “les sciences humaines seront des sciences naturelles ou ne seront pas”. Evidemment, sauf à en revenir à un réductionnisme dogmatique, une telle affirmation n’est soutenable que si l’on peut suffisamment généraliser le concept classique de “naturalité”, le généraliser jusqu’à pouvoir y faire droit, comme à des phénomènes naturels, aux phénomènes d’organisation structurale.
— Jean Petitot, [26, p. 1]

The nature of any entity, I propose, divides into three aspects or facets, which we may call its form, appearance, and substrate. In an act of consciousness, accordingly, we must distinguish three fundamentally different aspects: its form or intentional structure, its appearance or subjective “feel”, and its substrate or origin. In terms of this three-facet distinction, we can define the place of consciousness in the world.
— David Woodruff Smith, [?, p. 11]

The question of whether computers can be programmed to understand language may be philosophical, but it overlaps with broad methodological bifurcations: after all, linguists *are* programming computers to “understand” language, at least to some approximation. Given that computational linguistics is now a well-established practice, we can consider how this program for investigating the nature of language orients into linguistics as a whole: to what degree are the computers really “understanding” their linguistic input? How much does *behavior* consistent with language-understanding suggest actual understanding? Is linguistic competence mostly a behavioral phenomenon, or something more holistic and (inter-) subjective? Are the imperfections of automated Natural Language Processing inevitable, and if so, does that foreclose the possibility of NLP engines being considered truly linguistic? That is, should we treat flawed and oversimplistic (but practically useful) NLP software — or “personas” driven by this software, like “digital assistants”

— as bonafide (if rather primitive) participants in the world of human language? Or are they merely machines that simulate linguistic behavior without manifesting real linguistic behavior, as a computer simulation of a celestial galaxy is not a real galaxy?

These are methodological as well as thematic questions. There is a wide swath of formal and computational linguistics, for instance, for which the measure of a theory is its chance of being operationalized on NLP terms and within NLP tools, yielding automated systems whose accuracy and/or computational efficiency competes favorably with other systems. Faithfulness to how *humans* process language is at most a secondary concern. Conversely, there is a broad literature in Cognitive Linguistics and the Philosophy of Language for which uncovering the cognitive and interpretive registers through which *we* understand, produce, and are affected by language is the main goal. For scholars chasing that telos, failure to encode theoretical models in mathematical or software

systems is not *prima facie* an explanatory limitation — conversely, we might take this as evidence that cognitive models are addressing the deep, subtle realities of language that are opaque to computer simulation.

Then there is hybrid work, like attempts to formalize Cognitive Grammar (Matt Selway [30], Kenneth Holmqvist [14]), or other branches of Cognitive Linguistics (cf. Terry Regier’s influential [29]), or Conceptual Space Theory as initiated by Peter Gärdenfors (which has seen several attempts at mathematical-computational formalization, such as Frank Zenker, Martin Raubal, and Benjamin Adams’s metascientific perspectives, and more recent Category-Theoretic structures linked to mathematicians such as Bob Coecke and David Spivak [12]). To this list we could add research that extends beyond language alone to broader cognitive-perceptual and conceptual themes, like formal descriptions rooted in Husserlian analyses by phenomenologists whose methods encompass some computer-scientific techniques, like Barry Smith (as in [6]) and Jean Petitot (see [27]); we can see these accounts as generalizing cognitive-linguistic theories by noting the phenomenological basis of linguistic phenomena, as articulated by (say) Olav K. Wiegand ([35]) and Jordan Zlatev ([38]). In each of the works just cited (prior anyhow to the last two) we can find formal/computational models whose rationale is, in large part, to shed light on human cognitive processes (albeit not necessarily translating to practical NLP components in any straightforward way).

This kind of “intermediate” research is perhaps underappreciated, because it neither accepts the dismissive attitude that formal models are a distraction from the analysis of “real” language, nor the reductionistic faith that language is *intrinsically* computational, so that progress toward ideal NLP avatars is just a matter of time. To be sure, layering formal systems on a cognitive/phenomenological foundation adds a complexity of theoretical structure, which could prompt questions about the efficacy of the theoretical dilation: is extra complexity desirable as an end in itself, if the new formalizations have only limited explanatory or practical pay-offs? If there is a human kernel in language that is intrinsically non-computable and non-formalizable, does analysis of language truly benefit from complex but only partly applicable structural overlays? On the other hand, if language *is* computationally tractable, shouldn’t NLP implementation be a factor in assessing which formal

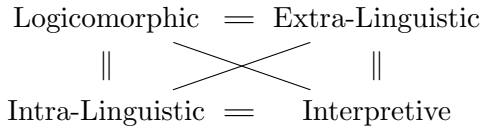
models are worthy of attention?

Perhaps for these kinds of considerations, linguistics seems to bifurcate between a camp that essentially ignores computational methodology and resources and a camp that centers its whole attention on building better automated NLP tools. Left out of this division is research that invokes formal models as explanatory vehicles while not enmeshing them in an ecosystem oriented toward automation — the difference between deploying formal representations to model (some aspects) of language processing, syntax, and semantics, and trying to program software to *automate* the construction, translation, and pipeline between and among formal models. When situating research relative to computational linguistics, we should bear in mind the metatheoretical point that *incorporating* formal schema into linguistics models does not *necessarily* mean committing ourselves to a task of programming computers to discover the target representations on their own, given raw linguistic input.

But this perspective is not only metatheoretical: I believe that the nature of language is *intrinsically* “hybrid” in a manner that warrants neither blind faith in automation nor *a priori* disengagement with formalizing projects. This is first of all because language is neither wholly isolated from other cognitive phenomena nor without some structural autonomy: it is reasonable to suppose that there are distinct intellectual faculties internal to our understanding of language, while other reasonings intrinsic to parsing the form and intentions of a linguistic unit are drawn from the wider inventory of situational, conceptual, social, and practical/enactive cognition. Sentences can vary in terms of their context-sensitivity and the degree to which extralinguistic rationality is implicit in grasping intended meanings. So neither a theory which ignores extralinguistic cognition, nor one which treats *all* linguistic processing as inseparable from the totality of our cognitive processes from moment to moment, are complete; the larger account needs to place sentences on a spectrum, where extralinguistic and (I’ll say) “intra-linguistic” theoretical machinery is available to analyze different sentences as their form and context demands.

Extending this point, I believe a comparable spectrum matches the duality of language seen as intrinsically formalizable and computable or as too subtle, social/cultural, embodied, and context-dependent to be

tractable to any computer or any idealized logicomathematical abstraction. Some sentence are more logically straightforward; others are more elusive, requiring holistic and context-sensitive interpretation on conversants' parts to be understood. Combined with my claims last paragraph, I argue accordingly that we can (at least as a suggestive picture) view linguistic artifacts (canonically, sentences) along a two-axis spectrum defined both by extralinguistic integration (or lack thereof) and by formal tractability (or lack thereof), like so: (this is intended as an intuitive sketch, not a formal model).



I will elucidate the terms on that picture later. Summarily, though, I claim that *some* sentences evince logically straightforward compositional patterns that can be analyzed *either* at the language-specific (syntactic or semantic) level *or* within cognitive registers outside of language proper (e.g., situational shemata); conversely, some sentences have nuances that call for interpretive judgments which appear to transcend formal simulacra outside the full range of human intelligence, emotion, and embodiment, *either* in terms of parsing complex syntactic or semantic structures *or* in grounding linguistic phenomena in ambient contexts. My overall point is then that sentences take a spectrum of models spanned by these axes; no one paradigm is self-contained as a metalinguistic commitment.

In effect, the choice between paradigms wherein language is or is not formally/computationally tractable, and between paradigms wherein language is or is not intellectually autonomous vis-à-vis our total cognitive faculties, should not be seen as a metaphysical alternative anterior to language as a totality. Instead, these spectra are threaded into language internally, competing polarities which rise or fall from sentence to sentence. Language is not *intrinsically* either formal or non-formal; autonomous or non-autonomous.

But at the same time, sentences are clearly phenomena of the same ilk; the distinctions I have made are not so sharp as to disrupt the ontological similitude among sentences, so that two sentences (however much they differ on the spectra of my diagram) are still manifestations

of the same ontological place; they are still roughly the same *sort* of existents. Accordingly, we should conclude philosophically that there are certain aspects of sentences that lie beneath the formal/interpretive and intralinguistic/extralinguistic dualities. There are, in short, paleostructures in language that manifest *either* with formal specificity or with contextual nuance; *either* internal to syntax or semantics or external to intrinsically linguistic cognition; varying from sentence to sentence. This paper will present a theory of one such paleostructure, drawing inspiration both from formal theories (Dependency Grammar, Type-Theoretic Semantics, Generative Lexicon) and from more philosophical approaches (Cognitive Grammar, Semiotics, Phenomenology).

The central element in my analysis is the *conceptual modification* implied or effected by one word in the presence of another word. More precisely, some words' linguistic roles can be analyzed as adding cognitive detail (conceptual and/or perceptual and/or pragmatic) to the ideas or referents signified via other words. The underlying scheme, at this level where the model is undeveloped and thus fairly simple, is close to Dependency Grammar: in lieu of a head/dependent relation we can treat one word (or similar lexical unit) as a *modifier* and the second as a "ground". I believe this two-pronged picture is not completely vacuous, but is general and underspecified enough to spread over both syntax and semantics, and over competing paradigms. I will call the modifier's effect on its ground a *transform*, and the two words together (taking "word" as a convenient designation for lexemes in general) as a *transform pair*.

I will argue that the underlying transform-pair concept is amenable to both more formal and more philosophical/interpretive development. On the one hand, transform-pairs can sometimes be mapped explicitly to dependency or link-grammar pairs, so the theory can be treated as a philosophical preliminary or motivation for Dependency or Link Grammar. Relatedly, transforms themselves can be integrated into type systems (e.g., the kinds of transforms associated with adjectives depend on their ground being typed as a noun), so a theory of transform-pairs can motivate elaboration in a Type-Theoretic context. On the other hand, we can focus on the interpretive and situational nuanced often evident in cognitive transformations to find evidence for linguistic phenomena which do not fit neatly into Dependency Grammar or Type-Theoretic (or any other) formaliza-

tion. These various continuations, which I will present further over the next several sections, try not to foreclose either formal or philosophical/interpretive paradigms. The goal is to trace both formal models of language and alternative models — for which excessive formalization is reductionistic and depends on ad-hoc avoidance of many real-world significations — to a common structural kernel from which both perspectives can be deployed on a case-by-case (e.g., sentence-by-sentence) basis.

In keeping with the perspective that formal models have *some* merit, I have tried to orient the presentation around certain computational-linguistic techniques. Some of my examples are drawn from popular annotated corpora, and I provide models of other examples as processed by representative NLP technologies (e.g., Malt Parser trained against the most recent Universal Dependency training data at the time of writing). I have packaged the examples and supporting code into an open-source data set for purposes of demonstration. I do not dwell on the accuracy of the NLP components, in part because I am motivated in this paper to examine how computational methods can be employed as explanatory tools separate and apart from their feasibility in automated pipelines. That is, the computational resources I present here are designed more as technological supplements to philosophical, interpretive, and speculative examinations of interesting linguistic examples, rather than as algorithms ultimately targeted at fully automated NLP frameworks. I incorporate code and data as a supplement to my argumentation in the hope that this can serve as an example of computational linguistics adopted outside the priorities of NLP automation and Artificial Intelligence in its more reductive, science-fictional sense. I am not aspiring to develop code or theoretical claims that could advance the hypothetical project of implementing artificial agents that can mimic and understand human language and behavior in all its subjectivity and complexity. However, I *do* want to leverage certain computational techniques as offering their own explanatory perspectives on structures in human language.

The remainder of this paper will draw and expand on the outline of terms and structures sketched thus far, specifically the contrast of intra/extra-linguistic and “logicomorphic”/interpretive aspects from my “diagram” of sentences’ paradigmatic spectrum, and the basic modifier/ground transform-pair account. I use the phrase

Cognitive Transform Grammar for the core notion of “transform-pairs” as, at core, cognitive phenomena, which nonetheless allow for further exposition via different methods. I will explain some of this variation in the first section.

1 Cognitive Transform Grammar and Transform-Pairs

The idea that inter-word pairs are a foundational linguistic unit — from which larger aggregates can be built up recursively — is an central tenet of Dependency Grammar. Here I will generalize this perspective outside (but not excluding) grammar, to overall semantic, pragmatic, and even extralinguistic relations indicated via interword relations.

In some cases word-relations can still be theorized mostly via syntax. Consider hypothetical, example sentences like

- ▼ (1) His having lied in the past damages his credibility in the present.
- ▼ (2) Voters question whether he is truthful this time around.

In (1), *having* is necessary to syntactically transform its ground *lied* from a verb-form to a noun (something which can be inserted into a possessive clause). Analogously, in (2) *whether* modifies *is* (since this is the head of a subordinate clause), wrapping a propositional clause into a noun so that it furnishes a direct object to the verb *question*. The essential transformation in these cases is motivated by grammatic considerations, particularly part-of-speech: a verb and a subordinate, propositionally complete clause (in 1 and 2, respectively) need (for syntactic propriety) to be modified so as to play a role in a site where a noun is expected (in effect, they need to be bundled into a noun-phrase).

The relevant transforms here — signified by *having* and *whether* — have a semantic dimension also, and we can speculate that the syntactic rules (requiring a verb or propositional-clause to be transformed into a noun) are actually driven by semantic considerations. Conceptually, for example, *his having lied* packages a verb into a possessive context because the sentence is not foregrounding a specific lying-event but rather the fact of the existence of such occasions. We cannot perhaps

“possess” an event, but we possess (as part of our nature or history) the fact of past occurrences, viz., events in the form of things we have done. In this sense *his having lied* marks a conceptual transformation, from events qua occurants to events (as factual givens) qua states or possessions, and the grammatical norm — how we cannot just say “his lied” — is epiphenomenal to the conceptual logic here; the erroneous “his lied” sounds flawed because it does not match a coherent conceptual pattern in how events and states fit together. But, still, the syntactic requirement — the expectation that a noun or noun-phrase serve as the ground of a possessive adjective, or the direct object of a verb — manifests these underlying conceptual patterns in the order of everyday language. Syntactic patterns become entrenched *because* they are comfortable translations of conceptual schema, but *as* entrenched we hear these patterns as grammatically correct, not just as conceptually well-formed. Likewise, we hear errata like “his lied” as *ungrammatical*, not as conceptually incongruous.

I contend, therefore, that many conceptually-motivated word-pairing patterns become syntactically entrenched and thus engender a class of transform-pairs where the crucial, surface-level transformation is syntactic, often in the form of translations between parts of speech, or between morphological classes (singular/plural, object/location, etc.). Consider locative constructions like

- ▼ (3) Let’s go to Grandma.
- ▼ (4) Let’s go to the lawyers.
- ▼ (5) Let’s go to the press.

Here nouns like *Grandma*, *the lawyers*, and *the press* are used at sites in the surrounding sentence-forms that call for a designation of place — this compels us to read the nouns as describing a place, even while they are not intrinsically spatial or geographical (e.g., Grandma is associated with the place where she lives).

In (5) and perhaps (4), this locative figuring may be metaphorical: going *to the press* does not necessarily mean going to the newspaper’s offices. Indeed, each of these usages are to some degree conventionalized: going *to Grandma* is subtler than going *to Grandmas house*, because the former construction implies that you are going to a *place* (“Grandma” is proxy for her house, say), but also Grandma is actually there, and that seeing her is the purpose of your visit. In other words, the specific *go to*

Grandma formation carries a supply of situational expectations. There are analogous implications in (4) and (5) — going *to the press* means trying to get some news story or information published. But the underlying manipulation of concepts, which structures the canonical situations implicated in (3)-(5), is organized around the locative grammatical form as binding noun-concepts to a locative interpretation. However metaphorical or imbued with additional situational implications, a person-to-location or institution-to-location mapping is the kernel conceptual operation around which the further expectations are organized. Accordingly, the locative case qua grammatic phenomenon signals the operation of these situational conventions, and the syntactic norms in turn are manifest via word-pairings, such as *to Grandma*.

In short, a transform-pair like *to Grandma* can be analyzed in several registers; we can see it as the straightforward syntactic rendering of a locative construction (via inter-word morphology, insofar as English has no locative case-markers) or explore further situational implications. In these examples, though, there is an obvious grammatic account of pairs’ transformations, notwithstanding that there are also more semantic and conceptual accounts. Part-of-speech transforms (like *having lied*) and case transforms (like *to Grandma*) are mandated by syntactic norms and therefore can be absorbed into conventional grammatic models, such as Dependency Grammar: the head/dependent pairings in *having lied* and *to Grandma* are each covered by specific relations within the theory’s inventory of possible inter-word connections. So a subset of transform-pairs overlaps with (or can be associated with) corresponding Dependency Grammar pairings.

Another potential embedding of transform-pairs into formal models can be motivated by Type Theory. This analysis can proceed on several levels, but in general terms we can assume that parts of speech form a functional type system (as elucidated, say, in Combinatory Categorical Grammar). For instance, we can recognize nouns and propositions (sentences or sentence-parts forming logically complete clauses) as primitive types, and treat other parts of speech as akin to “functions” between other types. A verb, say, combines with a noun to form a proposition, or complete idea: *go* acts on *We* to yield the proposition *We go*. Schematically, then, verbs are akin to functions that map nouns to propositions. Similarly, adjectives map nouns to nouns, and adverbs map verbs to other verbs (here I use “noun” or “verb”

to mean a linguistic unit which is functionally a noun, or verb; in this sense a noun-phrase is a kind of noun — i.e., a linguistic unit whose *type* is nominal). This provides a type-theoretic architecture through which transform-pairs can be analyzed. An adverb modifies a verb; so an adverb in a transform pair must have a verb as a ground. Moreover, the “product” of that transform is also a verb, in the sense that the adverb-verb pair, parsed as a phrase, can only be situated in grammatic contexts where a verb is expected.

In effect, we can apply type-theoretic models to both parts of a transform-pair and to the pair as a whole, producing structural requirements on how words link up into transform-pairs. We can then see an entire sentence as built up from a chain of such pairs, with the rules of this construction expressed type-theoretically. Given, say, *his having lied flagrantly* we can identify a chain of pairs *flagrantly-lied*, *having-flagrantly*, and *his-having*, where the “outcome” of one transform becomes subject to a subsequent transform. So *flagrantly* modifies *lied* by expressing measure and emphasis, adding conceptual detail; grammatically the outcome is still a verb. Then *having*, as I argued earlier, applies a transform that maps this verb-outcome to a noun, which is then transformed by the possessive *his*. Each step in the chain is governed by type-related requirements: the output of one transform must be type-compatible with the modifier for the next transform. This induces a notion of *type-checking* transform-chains, which is analogous to how type-checking works in formal settings like computer programming languages, Typed Lambda Calculus, and Dimensional Analysis.

This gloss actually understates the explanatory power of type-theoretic models for linguistics, since I have mentioned only very coarse-grained type classifications (noun, proposition, verb, adjective, adverb); more complex type-theoretic constructions come into play when this framework is refined to consider plural/singular, classes of nouns, and so forth, establishing a basis for more sophisticated structures adapted to language from formal type theory, like type-coersions and dependent types (I will revisit these theories in a later section). Here, though, I will just point out that Dependency Grammar and Type-Theoretic Semantics can often overlap in their analysis of word-pairs (inter-word relations is not centralized in type-oriented methodology as much as in Dependency Grammar, but type concepts can certainly be marshaled

toward word-pair analysis).

Even though Dependency and Type-Theoretic analyses will often reinforce one another, they can offer distinct perspectives on how pairs aggregate to form complete phrases and sentences. In the transform-pair *having lied*, *lied* is clearly the more significant word semantically. This is reflected in *having* being annotated (at least according to the Universal Dependency framework) as auxiliary, and the dependent element of the pair, while *lied* is the head. Then *lied* is also connected to *his*, establishing a verb-subject relation. So *lied* becomes the nexus around which other, supporting sentence elements are connected. This is a typical pattern in Dependency Grammar parses, where the most semantically significant sentence elements also tend to be the most densely connected (if we treat the parse-diagram as a graph, these nodes tend to have the highest “degree”, a measure of nodes’ importance to the degree as this is reflected in how many other nodes connect to it). Indeed, by counting word connections we can get a rough estimation of semantic importance, distinguishing “central” and “peripheral” elements. These are not standard terms, but they suggest a norm in Dependency Grammar that the structure of parse-graphs generally reflects semantic priority: the central “spine” of a graph, so to speak, captures the primary signifying intentions of the original sentence, while the more peripheral areas capture finer details or syntactic auxiliaries whose role is for grammatical propriety more than meaningful content.

Conversely, a type-theoretic analysis might incline us to question this sense of semantic core versus periphery: in the case of *his having lied*, the transform *having* supplies the outcome which is content for the possessive *has*. If we see the sentence as a cognitive unfolding, a series of mental adjustments toward an ever-more-precise reading of speaker intent, then each step in the transformation contributes consequential details to the final understanding. Moreover, *lied* is only present in the transformation signified by *his* insofar as it has in turn been transformed by *having*: each modifier in a transform-pair has a degree of temporal priority because *its* effects are directly present in the context of the following transformation. This motivates a flavor of Dependency Grammar where the head/dependent ordering is inverted: a seemingly auxiliary component (like the function-word to a content-word) can be notated as the head because its output serves as “input” to a subsequent transform. In the

analogy to Lambda Calculus, *his having lied* would be graphed with *having* being the head for *lied*, and *his* the head for *having*, reflecting the relation of functions to their arguments. In lisp-like code, this could be written functionally as (his (having lied)), showing *having* as one function, and *his* as a second one, the former’s output being the latter’s input.

Implicitly, then, Type-Theoretic Semantics and Dependency Grammar can connote different perspectives on semantic importance and the unfolding of linguistic understanding. I will explore this distinction further below, with explicit juxtaposition of parse graphs using the two methods. I contend, however, that the distinction reflects a manifest duality in linguistic meaning: we can treat a linguistic artifact as an unfolding process or as a static signification with more central and more minute parts. Both of these aspects coexist: on the one hand, we understand sentences via an unfolding cognitive process; on the other hand, this cognition includes forming a mental review of the essential points of the sentence, a collation of key ideas such as (for 1) *his*, *lied*, *damages*, and *credibility*. Given this two-toned cognitive status — part dynamic process, part static outline — it is perhaps understandable that different methodologies for deconstructing a sentence into word-pair aggregates would converge on different structural norms for how the pairs are interrelated, internally and to one another.

This analysis, which I will extend later, has considered transform-pairs from a syntactic angle — in the sense that I have highlighted pairs which obviously come to the fore via grammatical principles. As I indicated, I believe the notion of transform-pairs cuts across both syntax and semantics, so I will pivot to some analyses which attend more to the semantic dimension.

1.1 Semantic Analyses of Transform-Pairs

In the simplest cases, a transform-pair represents a modifier adding conceptual detail to a ground, like *black dogs* from *dogs*. But the nature of this added detail — and its evident relation to surface language — can be very varied. Compare between examples like:

- ▼ (6) I saw my neighbor’s two black dogs.
- ▼ (7) I saw my neighbor’s two rescued dogs.

- ▼ (8) I saw my neighbor’s two latest dogs.

Whereas (6) presents a fairly straightforward conceptual transformation, the detailing in (7) is a lot subtler; mentioning *rescued* dogs makes no reference to perceptual qualities, but rather implies intricate situational background. The term *rescued dogs* strongly suggests that the dogs were adopted by their current owner, probably after an animal-welfare organization found them abandoned, or removed them from a prior abusive owner. This kind of backstory is packaged up, as a kind of situational prototype, in the conventionalized phrase *rescued dogs*, implying a level of specificity more precise than the adjective *rescued* alone implies. Correspondingly, the verb *to rescue* when applied to dogs suggest more information than in more generic contexts.

The phrase *latest dogs* carries implications in its own right; we assume the neighbor had owned other dogs before. Of course “latest” implies some temporal order, but the understood time-scale depends on context. If we hear talk about a *vets* two latest dogs, we would presumably interpret this in terms of patients the vet has seen over the course of a day:

- ▼ (9) We have to wait until after the vet’s two latest dogs.
- ▼ (10) I’m concerned about the rescue organization’s two latest dogs.

Understanding the relevant time-frame depends on understanding the relation between the dogs and the possessive antecedent. In (8) the neighbor (in a typical case) actually owns the dogs, so the situational context grounding the modifier *latest* would be understood against the normal time-scale for dog ownership (at least several years). In (9), the vet only “possesses” the dogs in the sense of endeavoring to examine them, a process of minutes or hours. In (10), the implication of the *organization’s* possessive vis-à-vis rescued dogs is that the group endeavors to rehabilitate and find permanent homes for the rescuees. So in each case *latest* implies a succession of dogs, leading over time to two most recent ones, but the implied time-frame for our conceptualizing this sequence can be minutes-to-hours, or days-to-months, or years.

We should also observe that the implied time-frames and backstories in (7)-(10) are not directly signified via morphosyntax or lexical resources alone. The word

rescued only carries the *rescued dog* backstory when used in a context involving the dogs' eventual owners; in some context the more generic meaning of *rescue* could supercede:

- ▼ (11) Boatmen rescued dogs from the flooded streets.
- ▼ (12) Firemen rescued dogs from the burning building.

Neither (11) nor (12) imply that the dogs were abandoned, or will have new owners, or be sent to a shelter, or that their rescuers are members of an animal-welfare organization — in short, no element of the conventionalized backstory usually invoked by *rescued dogs* is present. Analogously, there is no lexical subdivision for *latest* which regulates the variance in time-frames among (8)-(10). It is only by inferring a likely situational background that conversants will make time-scale assumptions based on one situation involving dog ownership, another involving veterinary exams, and a third involving animal-welfare rehabilitation.

That is to say, the time-scale inference I have analyzed is essentially *extralinguistic*: there is no specific *linguistic* knowledge (lexical or grammatical, or even pragmatic inferences in the sense of deictic or anaphora resolution) which warrants the situational classification of (8)-(10) into different time scales. Instead, the inference is driven by (to some degree socially or culturally specific) background-knowledge about phenomena like veterinary clinics or animal rescue groups. Whether or not the nuances in *rescued dogs* are similarly extra-linguistic is an interesting question — we can argue that the phrase is now entrenched as a *de facto* lexical entrant in its own right, so the role of *rescued* is not only to lend adjectival detail but to construct a recurring phrase with a distinct meaning, like *red card* (in football) or *stolen base* (in baseball). Lexical entrenchment is, I would argue, an intra-linguistic phenomenon, in the sense that understanding entrenched phrases is akin to familiarity with specific word-senses, which is a properly linguistic kind of knowledge. But even in that case, entrenchment is only possible because the phrase has a signifying precision more rigorous than its purely linguistic composition would imply. There are, in short, extralinguistic considerations governing *when* phrases are candidates for entrenchment, and a language-user's ability to learn the conventionalized meaning (which I believe is an intra-linguistic cognitive development) depends on their having the relevant (extra-linguistic) background knowledge.

If we consider then the contrast between transform-pairs like *black dogs*, *rescued dogs*, and *latest dogs*, the similar grammatic constructions — indeed similar semantic constructions, in that each pair has an adjective modifying a straightforward plural noun (*dogs* designates a similar concept in each case; this is not a case of surface grammar hiding semantic diversity, like *strong wine* vs. *strong opinion* or *long afternoon* vs. *long snake*) — package transforms whose cognitive resolution spans a range of linguistic and extralinguistic considerations. Straightforward adjectival modification in *black dogs* gives way to lexical entrenchment in *rescued dogs* which, as I argued, carries significant extra-linguistic background knowledge even though possession of this knowledge is packaged into basic linguistic familiarity with *rescued dogs* as a signifying unit; and in the case of *latest dogs* the morphosyntactic evocation of temporal precedence and two different multiplicities (the latest dogs and earlier ones) is fleshed out by extra-linguistic estimations of time scale. The same surface-level linguistic structures, in short, can (or so such examples argue for) lead conversants on a cognitive trajectory in which linguistic and extra-linguistic factors interoperate in many different ways.

This diversity should call into question the ability of conventional syntactic and semantic analysis to elucidate sentence-meanings with any precision or granularity. Lexical and morphosyntactic observations may certainly reflect details which *contribute* to sentence-meanings, but the overall understating of each sentence in context depends on holistic, interpretive acts by competent language users in light of extra-linguistic, socially mediated background knowledge and situational understanding. Contextuality applies here not only in the pragmatic sense that pronoun resolution, say, depends on discursive context (who is *her* in *her dogs*); more broadly, transcending even pragmatics, context describes presumptive familiarity with conceptual structures like veterinary clinics, animal shelters, and any other real-world domain which provides an overall system wherein particular lexical significations can be standardized. Without the requisite conceptual background it is hard to analyze how speakers can make sense even of well-established variations in word-sense, like *treat* as in a veterinarian treating a dog, a doctor treating a wound, a carpenter treating a piece of wood, or how an actor treats a part. These senses have lexical specificity only in the domain-specific contexts of medicine, carpentry, theater, and so

forth.

The problem of holistic cognitive interpretation (as requisite for sentence-meanings) can be seen even more baldly in examples where semantic readings bifurcate in ways wholly dependent on extra-linguistic conceptualization. Consider for instance:

- ▼ (13) All New Yorkers live in one of five boroughs.
- ▼ (14) All New Yorkers complain about how long it takes to commute to New York City.

In (13), *New Yorkers* refers specifically to everyone who lives in the City of New York, since the five boroughs collectively span the whole of city. In (14), by contrast, we should understand *New Yorkers* as referring to residents of the metropolitan area *outside* the city itself (who commute *to* the city); and moreover *All* should be read less than literally: we do not hear the speaker in (14) committing to the proposition that *every single* New Yorker complains. So both *All* and *New Yorkers* have noticeably different meanings in the two sentences.

And yet, I cannot find any purely linguistic mechanism (lexical, semantic, syntactic, morphological) which would account for these difference as linguistic signifieds *per se*: the actual differences depend on conversants knowing some details about New York geography, and also general cultural background. It does not make too much sense to commute to a place where you already live, so our conventional picture of the word *commute* constrains our interpretation of (14) — but this depends on *commute* having a specific meaning, of traveling in to a city, usually from a suburban home, on a regular basis; a meaning in turn indebted to the norms of the modern urban lifestyle (it would be hard derive an analogous word-sense in the language spoken by a nomadic tribe, or a pre-industrial agrarian community). Likewise, reading *All* in (13) as *literally* “all” depends on knowing that the five boroughs are in fact the whole of the city’s territory.

Given that in everyday speech quantifiers like *all* or *every* are often only approximate — and that designations like *New Yorker* are often used imprecisely, with not-identical alternative meanings intended on a case-by-case basis — these kind of examples point to signifying ambiguities that can easily arise as a consequence. Often extra-linguistic considerations resolve the ambiguity by rejecting one or another (otherwise linguistically plausible) reading as non-sensical. Consider:

- ▼ (15) The Leafs failed to beat the Habs for the first time this year.
- ▼ (16) The Leafs failed to win two consecutive games for the first time this year.
- ▼ (17) The Leafs failed to score a goal for the first time this year.

Sentence (15) has two competing readings: either the Toronto Maple Leafs won *all* or *none* of their previous games, in the relevant year, against the Montreal Canadiens. The difference is whether *for the first time this year* attaches to *beat* or to *fail*. In (16), on the other hand, the only sensible interpretation is that the Leafs had not yet won two games: while it is logically accurate to describe a team on a long winning streak as repeatedly winning two consecutive games, it would be very unexpected for (16) to be used in a case where the Leafs lost their first game of the season, after a three-plus-game winning streak. And in (17) any hockey fan would hear that the Leafs had scored at least one goal in all prior games; even though there is no linguistic rule foreclosing the reading such that the Leafs have not scored a goal in *any* game.

These variations — the degree to which superficial ambiguity is actually perceived by competent language-users as presenting competing plausible meanings — depend on background factors; the contingencies of hockey fix how potential ambiguities resolve out because one or another alternative is extralinguistically incoherent. But these cases point to how linguistic criteria alone, no matter how broadly understood, cannot necessarily predict in what sense linguistic structurations have empirically plausible meanings — or whether they have sensible meanings at all.

Notice however that the examples have alternate versions which are less subtle or ambiguous, which shows that the complications are not localized in the communicated ideas themselves, but in their typical linguistic encoding:

- ▼ (18) All residents of the city of New York live in one of five boroughs.
- ▼ (19) Many residents of the New York metropolitan area complain about how long it takes to commute to New York City.
- ▼ (20) For the first time this year, the Leafs failed to beat the Habs.

These versions are more logically transparent, in that their propositional content is more directly modeled by the structure of the sentences. Indeed, hearers unfamiliar with New York or with hockey might find these versions easier to understand; more context-neutral and journalistic. But perhaps for this reason the “journalistic” versions actually sound stilted or non-idiomatic for everyday discourse.

In short, even if sentences have a basically transparent logical content, *how* sentences holistically signify this content does not always emerge straightforwardly from semantic or syntactic structures on their own. I think this weakens the case for semantic paradigms which concentrate on logically-structured content which appears to be signified through sentences — even if we grant that this propositional ground of meaning is real, it does not follow that propositional contents are designated by purely linguistic means, rather than by a cohort of cognitive processes many of which are extra-linguistic. This is the basis of my proposing “logicomorphic” qualities as one axis for evaluating sentences, which I will now discuss further.

1.2 Logical Structure versus Sentence Structure

Let us grant in general that particular sentences can be mapped to distinct, relatively transparent propositional contents. In some cases sentences expresses propositional attitudes to such content (requests, commands, questioning) rather than unadorned locutionary assertions. To properly respond to speech-acts, however (even ones with illocutionary force) conversants need to derive the content which is logically conjured via the discourse, either as the speaker’s primary intent or as a condition for that intent. In effect, a proposition like *the window is closed* furnishes logical content to assertions like *The window is closed now* but also statements of belief (*I think the window is closed*) or requests or opinions (*The window should be closed; Please close the window*).

Philosophical treatments of language often imply that such propositional contents are the *essential* meanings within language; that analyzing semantic forms via logical structure is the core of a rigorous theory of semantics. It is certainly true that many elements of language can be translated, or deemed as conventionalized encodings

for, structures in predicate logic — invocations of multiplicity and quantification; logical connectives between propositions; negations, modalities, and possibilities. This provides an analytic matrix wherein *some* sentences’ structures may be analyzed. I will argue, however, that in typical cases logical forms are invoked only indirectly — which calls into question the applicability of logical analysis as explanatory vehicles for *linguistic* analysis in itself (as opposed to more general cognitive/extralinguistic processing).

There are several cognitive operations requisite for grasping sentence-meanings as a logical gestalt: figuring individuals or multiplicities as conceptual foci (verb subjects or objects); establishing relationships between individuals and multiplicities or among multiplicities (member/part of, larger/smaller, overlap/disjoint); predicating properties to individuals or multiplicities; quantification; logical conjunction or disjunction, between predicates (also negation). In some cases we can find these operations fairly directly encoded in explicit language form — sentences which are precise in figuring multiplicities numerically, or through unambiguous use of determiners like *all* and *every*; which are structured to avoid scope ambiguities; which use transparent semantic resources to describe verb subjects and objects; and so forth. In the most recent Universal Dependencies Shared Task corpus we can find examples like:

- ▼ (21) It is the most common tumour found in babies, occurring in one of every 35,000 births. (en_pud)
- ▼ (22) Dengue fever is a leading cause of illness and death in the tropics and subtropics, with as many as 100 million people infected each year. (en_partut-ud-train)
- ▼ (23) Many Taliban living in Afghanistan voted for President Karzai. (en_ewt-ud-train)
- ▼ (24) Most of the girls I was meeting had grown up in Mujahedeen schools in Ashraf, where they lived separated from their parents. (en_ewt-ud-train)
- ▼ (25) Most experts believe China intends to develop a small space station of its own over the next several years. (en_ewt-ud-train)
- ▼ (26) Check out their wine tastings every Friday night! (en_ewt-ud-train)
- ▼ (27) For each start tag , there is a corresponding end tag. (en_lines-ud-train)
- ▼ (28) Each collection donated by the Andy Warhol Photographic Legacy Program holds Polaroids of well-known celebrities. (en_gum-ud-train)

These sentences have straightforward logical structure, in terms of how they establish topical foci (*one of every 35,000 births, as many as 100 million people, Many Taliban, every Friday night, For each start tag*), and how predicates or references are bound together to create more precise significations (*the tropics and subtropics, in Mujahedeen schools in Ashraf, a corresponding end tag*). Properties ascribed to subject foci are neatly drawn, both in conveying the property intended and its bearer, according to the sentence’s terms: *the most common tumour found in babies, a leading cause of illness and death, China intends to develop a small space station, holds Polaroids of well-known celebrities*. With aggregate foci and/or quantification, there is an unambiguous framing of predication and quantifier scope — Each collection has its set of Polaroids; the set of Karzai voters, Dengue infections, birth tumours, etc., are crisply figured.

For many philosophers of language, identifying similar logical structuration is an intrinsic aspect of coming to terms with human language in general. This paradigm also reinforces the goal of Artificial Intelligent Natural Language Processing, because computers can certainly engage in the kind of symbolic-logical reasoning outlining signified meanings in cases where language reciprocates propositional morphology very clearly. The problem is that language artifacts very often cloak their logical core, such that examples like (21)-(28) are not representative of language as a whole. Logical patterns may certainly be present, but they are not necessarily structurally reproduced in surface-level formations; rather a sentences’ propositional content may depend on a subtle interpretive trajectory. I will present examples throughout this paper, but a few further corpus items are reasonable case-studies:

- ▼ (29) A furry black band of ants led up a cupboard door to some scrap that had flicked from a plate. (en_lines-ud-train)
- ▼ (30) The current waiting period is eight weeks. (en_pud)
- ▼ (31) I think that’s why they immersed themselves in pattern and colour. (en_pud)
- ▼ (32) With her appearance finalized, Jasmine became Disney’s first non-white princess as opposed to being of European heritage. (en_pud)

It requires a certain cognitive flexibility to understand a band of ants as “flurry”, or to parse the disjoint time-frames in *current waiting period*. In (31), the presumed

sense of “immerse” transcends any immediate, perceptual immersion, instead involving scholarship or engagement with artistic form; and (32) depends on us understanding the meaning of temporality in Jasmine’s appearance being *finalized*, and also her *becoming* non-white. As a fictional character, discourse about Jasmine can be evaluated in the time-frame of her artistic creation, distinct from the fictional time of her narrated world.

I think the intended propositional content in (29)-(32) is no less evident than in (21)-(28); however, interpreting the topical foci and predicate attributions constituting such propositional content requires a holistic reading whose compositional structure is not recapitulated in the sentence-forms themselves. In the latter examples, then, merely notating propositional content in logical fashion does not yield a very informative *linguistic* analysis, since it does not address the key question of *how* the sentences signify those propositions.

I propose to use the term “logicomorphic” for sentence in the former vein; in such cases, pointing out propositional content is linguistically useful because we can treat that content as a prototype for sentence organization. That is, propositional content is not only *holistically* signified but, in its logical structure, sheds light on pattern in the language. The purpose of phraseology like *most common tumour, Many Taliban living in Afghanistan, Most of the girls I was meeting*, etc., is to circumscribe a focus or a property suitable for predication, and we can logically model the tools used to do so: logical superlative (*most common*), assertions of magnitude (*Many, Most of*), refining an multiplicity with some further criteria (*the girls I was meeting, Taliban living in Afghanistan*), and so forth. These are “logicomorphic” constructions in that we can read the logical structure of signified propositional content as a direct cause of the given phrasal morphology.

On the other hand, I call examples like (29)-(32) “interpretive” because the sentences’ propositional content, with its logical structure, does not explain the compositional rationale for the explicit linguistic form: we cannot read any pattern in the logic as a direct motivation for how the sentence is pieced together. The spectrum between *logicomorphic* and *interpretive* represents different strategies by which language is composed in anticipation of its cognitive reception, with the eventual goal of establishing a signified propositional content, but in different

ways. On the logicomorphic side, logical form informs language directly; on the interpretive side, the actual rationale for compositional structures transcends exact predicative structure — a more perceptual or indirect figuring of topical focus, for instance, or a more elliptical construal of predicate attributes, leaving the hearer to piece together the final propositional via some pragmatic or extralinguistic calculation.

Accordingly, the *logicomorphic/interpretive* distinction — along with the overall contrast between linguistic and extralinguistic aspects of meaning — are contrasts between sentences that become manifest in the compositional maxims evident at subsentence (phrasal and inter-word) scales. We can apply all four criteria to estimate the cognitive as well as syntactic and semantic paradigms in effect for given inter-word pairs and phrasal structure; identifying sentences as logicomorphic or interpretive propagates down to how phrasal and interword patterns should be analyzed. With this in mind, having presented certain claims as to the holistic nature of sentences vis-à-vis propositional content, I will now switch attention to the composition of sentences from the interword level upward.

2 Functional Type Theory and Dependency Grammar

My discussion so far has focused on characterizing sentences' holistic meaning. On the face of it, such holistic analysis is more semantic than syntactic. However, syntactic paradigms can be grounded in theories of how language elements aggregate *toward* holistic meaning.

Here I propose a notion of “cognitive transforms” — that holistic meanings emerge from a series of interpretive and situational modeling modifications which progressively refine our understanding of a speaker's construal of our environing context and her propositional attitudes. While elucidation of these transforms as cognitive phenomena may belong to semantics, syntactic structure dictates the *sequence* of transforms. Many transforms are expressed by individual word-pairs. Taking the temporal or logical order of transforms into consideration, we can derive a syntactic model of sentences by introducing an order among word-pairs — a methodology akin to using Dependency Grammar parse-graphs as an inter-

mediate stage, then ordering the graph-edges around an estimation of cognitive aggregation. One transform is a successor to a predecessor if the modifications induced by the predecessor are consequential for the cognitive reorientation pertinent to the successor, and/or to the morphosyntactic features which trigger it.

In this spirit I talk of Cognitive Transform *Grammar*, because while in the general case transforms are semantic and interpretive — not the purview of grammar per se — we can theorize grammar as governing the *order of precedence* among transforms. More precisely, there is a particular order of precedence germane to sentence meaning; sentences have their precise syntax in order to compel recipients' reception of the linguistic performance according to that same ordering.

From this perspective, an essential aspect of grammar theory is that whatever units are understood as syntactic constituents — like phrase structure or word-pairs — an order of precedence should “fall out” of grammatic reconstructions. We should be able to supplement parse-representations with a listing of salient syntactic features in order, retracing the *cognitive* steps by which localized alterations in sense synthesize into holistic meaning. The details of this precedence-establishment will vary across grammatic paradigms, so one way to assess grammar theories is to consider how the engender corresponding cognitive-transform models.

A common paradigm is to consider natural-language types as generated by just two bases — a noun type N and a proposition type $Prop$, the type of sentences and of sentence-parts which are complete ideas — having in themselves a propositional content (see e.g. [4] or [17]). Different models derive new types on this basis in different ways. One approach, inspired by mathematical “pregroups”, establishes derivative types in terms of word pairs — an adjective followed by a noun yields another noun (a noun-phrase, but N is the phrase's *type*) — e.g., *rescued dogs*, like *dogs*, is conceptually a noun. Adjectives themselves then have the type of words which form nouns when paired with a following noun, often written as N/N . Pregroup grammars distinguish left-hand and right-hand adacency — *bark loudly*, say, demonstrates an adverb *after* a verb, yielding a verb phrase: so “loudly” here has the type of a word producing a verb in combination with a verb to its *left* (sometimes written $V \backslash N$); by contrast adjectives combine with nouns to their *right*.

A related formalization, whose formal analogs lie in Typed Lambda Calculus, abstracts from left-or-right word order to models derived types as equivalent (at least for purposes of type attribution) to “functions”. This engenders a fundamental notion of functional *application* and operator/operand distinctions:

Categorial Grammars make the connection between the first and the second level of the ACG. These models are typed applicative systems that verify if a linguistic expression is syntactically well-formed, and then construct its functional semantic interpretation. They use the *fundamental operation of application* of an operator to an operand. The result is a new operand or a new operator. This operation can be repeated as many times as necessary to construct the linguistic expressions’ functional semantic representation. [?, p. 1]

So, e.g., an adverb becomes a function which takes a verb and produces another verb; an adjective takes a noun and produces another noun; and a verb takes a noun and produces a proposition. By “function” we can consider some kind of conceptual transformation: *loudly* transforms the concept *bark* into the concept *loud bark*. Assuming all lexemes are assigned a Part of Speech drawn from such a type system, the definition of functional types directly yields a precedence order: instances of functional types are functionally dependent on their inputs, which are therefore precedent to them. On this basis, any well-typed functional expression has a unique precedence ordering on its terminal elements (i.e., its “leaves” when the expression is viewed as a tree, or its nodes when viewed as a graph), which can be uncovered via a straightforward algorithm (one implementation is part of this paper’s data set; see the “`parse_sxpr`” method in file `xxx.cpp`).

Functional parts of speech that can be formally modeled with one “argument” (the most common case), having a single input and output type, conveniently lend themselves to cognitive transforms defined through word pairs — an adjective modifies a noun to another noun, an adverb maps a verb to a verb, an auxiliary like *that* or *having* can map verbs or propositions to nouns, and so forth. The only main complication to this picture is that verbs, which typically have subjects as well as objects, can take two or three “inputs” instead of just

one. Instead of a transform *pair* we can then consider a three- or four-part transform structure (verb, subject, direct object, indirect object). We can still assign a precedence ordering to verb-headed phrases, however, perhaps by stipulating that the subject takes precedence before the direct object, and the direct object before the indirect. This ordering seems cognitively motivated: our construal of the significance of a direct object appears to intellectually depend on the verb’s subject; likewise the indirect object depends on the direct object to the degree that it is rationally consequential.

A secondary complication involves copulae like *and*, which can connect more than two words or clauses. Here, though, a natural ordering seems to derive from linear position in the sentence: given *x*, *y*, and *z* we can treat *x* as precedent to *y*, and *y* to *z*, respectively.

In total, sentences as a whole can thus be seen as structurally akin to nested expressions in lambda calculi (and notated via “S-Expressions”, like code in the Lisp programming language). S-Expressions are occasionally recommended as representations for some level of linguistic analysis (cf. [28], [31], [11]), and if this form by itself may add little extra data, it does offer a succinct way to capture the functional sequencing attributed to a sentence during analysis. Given, say,

- ▼ (33) The city’s ambience is colonial and the climate is tropical.
(`en_gum-ud-train`)

the gloss (and (is ((The (’s city)) ambience) colonial) (is (the climate) tropical)) summarizes analytic commitments with regard to the root structure of the sentence (in my treatment the copula is the overall root word) and to precedence between words (which words are seen as modifiers and which are their ground, for instance). So even without extra annotations (without, say, the kind of tagging data included by treebanks using S-Expression serializations), rewriting sentences as nested expressions captures primitive but significant syntactic details.

Nested-expression models also give rise directly to two other representations: a precedence ordering among lexemes automatically follows by taking function inputs as precedent to function (words) themselves¹; moreover, S-Expression formats can be rewritten as sets of word-pairs, borrowing the representational paradigms (if not identical structures) of Dependency Graphs. This allows Dependency Graphs and S-Expressions to be juxtaposed, which I will discuss in the remainder of this

¹But note that using “function-words” as terminology here generalizes this term beyond its conventional meaning in grammar.

section.

2.1 Double de Bruijn Indices

Assume then that all non-trivial sentences are nested expressions, and that all lexemes other than nouns are notionally *functions*, which take typed “inputs” and produce typed “outcomes”. Expression “nesting” means that function inputs are often outcomes from other functions (which establishes a precedence order among functions). Since there is an obvious notion of “parent” — instances of functional types are parents of the words or phrase-heads which are their inputs — nestable expressions are formally trees. Via tree-to-graph embedding, they can also be treated as graphs, with edges linking parents to children; since parse-graphs are canonical in some grammar theories (like Link and Dependency grammar), it is useful to consider the graph-style representation as the intrinsic structure of linguistic glosses based on S-Expressions. That is, we want to define a Category of labeled graphs each of whose objects is isomorphic to an S-Expression (using this terminology in the sense of mathematical Category Theory); equivalently, a bijective encoding of S-Expressions within labeled graphs given a suitable class of edge-labels.

Indeed, labels comprised of two numbers suffice, generalizing the lambda-calculus “de Bruijn Indices”. The de Bruijn notation is an alternative presentation of lambda terms using numeric indices in lieu of lambda-abstracted symbol. The *double* indices accommodate the fact that, in the general case, the functional component of an expression may be itself a nested expression, meaning that “evaluation” has to proceed in several stages: a function (potentially with one or more inputs) is evaluated, yielding another function, which is then applied to inputs, perhaps again yielding a function applied to still more inputs, and so forth. I use the term “evaluate” which is proper to the computer-science context, but in linguistics we can take this as a suggestive metaphor. More correctly, we can say that a function/input structure represents a cognitive transform which produces a new function (i.e., a phrase with a function-like part of speech), that is then the modifier to a new transform, and so forth. In general, the result of a transform can either be the *ground* of a subsequent transform, which is akin to passing a function-result to another function; or it can be the *modifier* of a subsequent transform, which is akin to evaluating a nested expression to produce a new function, then applied to other inputs in turn.

For a concrete example, consider

- ▼ (34) The most popular lodging is actually camping on the beaches. (en_gum-ud-train)

with gloss, as I take it, ((actually is) ((The (most popular)) lodging) ((on (the beaches)) camping)).

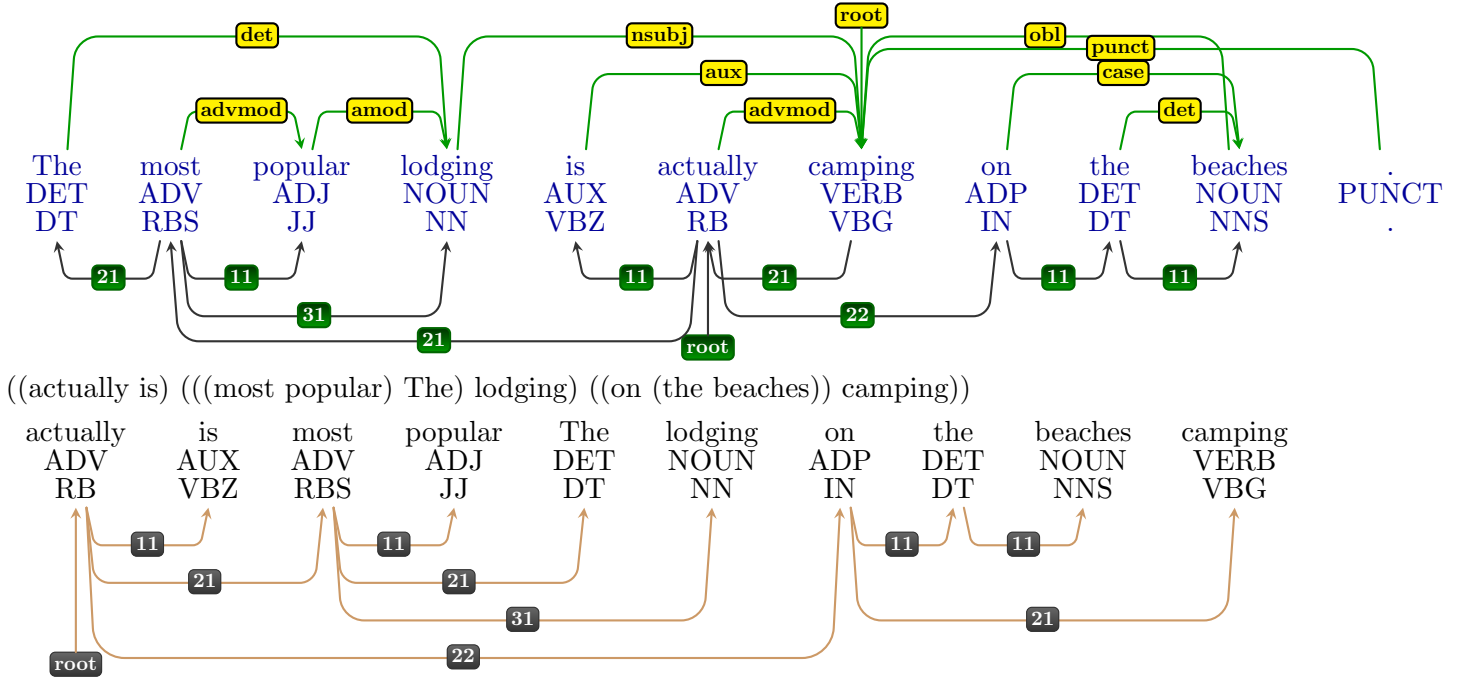
Here the adverb *actually* is taken as a modifier to *is*, so we imagine that interpreting the sentence involves first refining *is* into *is actually*, yielding a new verb (or “verb-idea”) that then participates in verb-subject-object pattern. Hence, the parse opens with the evaluation (*actually is*) in the head-position of the sentences top-level expression. Similarly, I read *on the beaches* as functionally a kind of adverb, like *camping outside*. In the generic pattern, a verb can be paired with a designation of location to construct the idea of the verb happening at such location; the designation-of-location is then a modifier to the verb’s ground. When this designation is a locative construction, the whole expression becomes a modifier, while it also has its own internal structure. In *on the beaches*, *on* serves as a modifier which maps or reinterprets *the beaches* to a designation of place. So here is the unfolding of the phrase: in *the beaches* the determinant (*the*) is a modifier to the ground *beaches*, signifying that *beaches* are to be circumscribed as an aggregate focus. Then *on* modifies the outcome of that first transform, re-inscribing the focus as a place-designation. Then *that* transform’s output becomes a modifier for *camping*, wherein the locative construction becomes a de-facto adverb, adding detail to the verb *camping* (camping on the beach as a kind of camping, in effect).²

Notice in this review that *the* as modifier in *the beaches* yield a pair whose outcome is the *ground* for *on*. If we take the modifier as representative for a modifier-ground pair, *the* is the *modifier* in its own transform pair but then the *ground* in the subsequent pair; the pattern is modifier-then-ground. However, *on* is the modifier vis-à-vis *the* and then *also* modifier vis-à-vis *camping*; the pattern is modifier-then-modifier. This latter case is the scenario where a lexeme will be a modifier on two or more different “levels”, giving rise to the “doubling” of de Bruijn indices. The first index, that is, represents the “level” tying a modifier to a ground, while the second index is the *normal* notation of lambda-position. In *camping on the beaches*, the indices for the pair *on the* would be 1,1 (meaning *the* is the first argument to *on* on the first transform level); the indices for *on camping* would be 2,1 (*camping* is the first argument to *on* on the *second* transform level).

By combining an index for “transform levels” — capturing cases where a modifier produces an outcome which is a modifier again, not a ground — with an index for lambda position (e.g. the direct object has index 2 relative to the verb, and the indirect object has index 3), we can transform any expression-tree into a labeled graph. Parse graphs can then be annotated with these double-indices via the same presentations employed for Link or Dependency Grammar labels. Sentence (??) could

²If it seems better to read camping as a *noun* — the act or phenomenon of camping — then we could treat the locative as an *adjective*, with the stipulation that the operation converting verbs to nouns (from *X* to the phenomenon, act, or state of *X*-ing) propagates to any modifiers on the verb: modifying constructions that refine *X* as verb are implicitly mapped to be adjectives likewise modifying *X* in the nominal sense of “the phenomenon of *X*-ing”.

Figure 1: Parse Graph with Dependency Relations as well as Double (Functional-Type) Indices



be visualized as in Figure ??, with the double-indices can be juxtaposed with conventional Dependency labels (the indices below the sentence, and relation labels above it); the upper parse is drawn from the Universal Dependency corpus (other annotated examples are included in this paper’s downloadable data set).

As a natural corollary to this notation, parts of speech can have “type signatures” notionally similar to the signatures of function types in programming languages: a verb needing a direct object, for example, “transforms” two nouns (Subject and Object) to a proposition, which could be notated with something like $N \rightarrow N \rightarrow Prop$. The notation is consistent so long as each constituent of a verb phrase has a fixed index number.³ Transforms (potentially with two or more arguments) then combine lexemes with particular signatures with one or more words or phrases. Type analysis recognizes criteria on these combinations, insofar as the phrases or lexemes at a given index have a type consistent with (potentially a subtype of) the corresponding position in the head-word’s signature. Ideally, this representation can explain *ungrammatical* constructions via *failure* for these types to align properly. If the combination “type-checks”, then we can assign the phrase as a whole the type indicated in the signature’s output type — $Prop$ in $N \rightarrow N \rightarrow Prop$, say; in this case the signature points out how $Prop$ derives from the phrase with two N s as its components (along with the verb), a derivation we could

in turn notate like $N \rightarrow N \rightarrow Prop \Rightarrow Prop$. A resulting phrase can then be included, like a nested expression, in other phrases; for instance a $Prop$ joined to *that* so as to create a noun-phrase (recall my analysis of *question whether* last section); notationally $Prop \rightarrow N \Rightarrow N$.⁴

Type “signatures” like $N \rightarrow N \rightarrow Prop$ may seem little more than notational variants of conventional linguistic wisdom, such as sentences’ requiring a noun (-phrase) and a verb ($S = NP + VP$). Even at this level, however, type-theoretic intuitions offer techniques for making sense of more complex, layered sentences, where integrating Dependency Graphs and phrase structures can be complex. One complication is the problem of applying Dependency Grammar where phrases do not seem to have an obviously “most significant” word for linkage with other phrases.

Often phrases are refinements of one single crucial component — a phrase like *many students* becomes in some sense collapsible to its semantic core, *students*. In real-world examples, however, lexemes tend to be neither wholly subsumed by their surrounding phrase nor wholly autonomous:

- ▼ (35) Many students and their parents came to complain about the tuition hikes.
- ▼ (36) Many students came by my office to complain about

³The subject at position one, for instance; direct object at position two; and indirect object at position three.

⁴Numeric indices take the place of left and right adjacency — “looking forward” or backward — in Combinatory Categorical Grammar; the type-theoretic perspective abstracts from word order. The theory of result types “falling out” from a type-checked phrase structure, however, carries over to this more abstract analysis.

their grades.

- ▼ (37) Student after student complained about the tuition hikes.
- ▼ (38) Student after student came with their parents to complain about the tuition hikes.

In (35) and (36), we read *Many students* as topicalizing a multitude, but we recognize that each student has their own parents, grade, and we assume they came to the office at different times (rather than all at once). So *students* links conceptually with other sentence elements, in a way that pulls it partly outside the *Many students* phrase; the phrase itself is a space-builder which leaves open the possibility of multiple derived spaces. This kind of space-building duality is reflected in how the singular/plural alternative is underdetermined in a multi-space context; consider Langacker’s example:

- ▼ (39) Three times, students asked an interesting question.
- ▼ (40) Three times, a student asked an interesting question.

Meanwhile, in (37) and (38) the phrase *Student after student* invokes a multiplicity akin to *Many students*, but the former phrase has distinct syntactic properties; in particular we can replace *their parents* (which is ambiguous between a plural and a gender-neutral singular reading) with, say, *his parents* (at a boy’s school), a valid substitution in (37)-(38) but not (35)-(36).

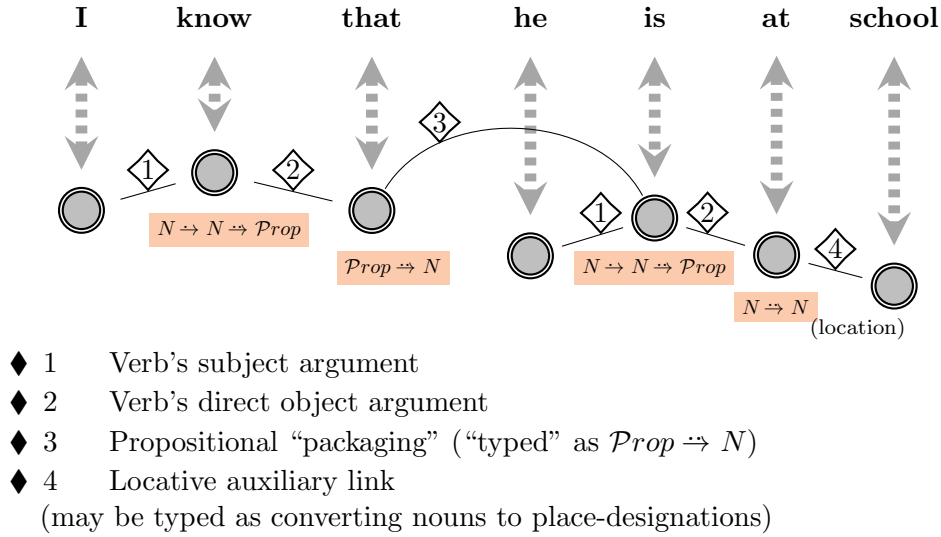
Cases like *Student after student* (or consider *time after time*, *year after year*, and so forth; this is a common idiomatic pattern in English) present a further difficulty for Dependency Grammar, since it is hard to identify which word of the three is the more significant, or the “head”. Arguably Constituency Grammar is more intuitive here because then phrases as a whole can get linked to other phrases, without needing to nominate one word to proxy the enclosing phrase. As I feel the “students” examples illustrated, however, it is too simplistic to treat phrases as full-scale replacements for semantic units, as if any phrase is an ad-hoc single lexeme (of course some phrases *do* get entrenched as de facto lexemes, like *Member of Parliament*, or my earlier examples *red card* and *stolen base*). In the general case though component words retain some syntactic and semantic autonomy (entrenchment diminishes but does not entirely eliminate such autonomy). There is, then, a potential dilemma: phrases link to other phrases (sometimes via subsumption and sometimes more indirectly, as in anaphora resolution), but phrases are not undifferentiated units; lexemes, which on this sort of analysis *are* units, can be designated as proxies for their phrase; but then we can have controversy over which word in a phrase is the most useful stand-in for the whole (‘cite’₂ has an interesting review of a similar controversy in Dependency Grammar).

Incorporating type theory, we can skirt these issues by modeling phrases through the perspective of type signatures:

given Part of Speech annotations for phrasal units and then for some of their parts, the signatures of other parts, like verbs or adjectives linked to nouns, or adverbs linked to verbs, tend to follow automatically. A successful analysis yields a formal tree, where if (in an act of semantic abstraction) words are replaced by their types, the “root” type is something like *Prop* and the rest of a tree is formally a reducible structure in Typed Lambda Calculus: $N \rightarrow N \rightarrow Prop$ “collapses” to *Prop*, $Prop \rightarrow N$ collapses to *N*, and so forth, with the tree “folding inward” like a fan until only the root remains — though a more subtle analysis would replace the single *Prop* type with variants that recognize different forms of speech acts, like questions and commands. In Figure 2, this can be seen via the type annotations: from right to left $N \rightarrow N$ yields the *N* as second argument for *is*, which in turn yields a *Prop* that is mapped (by *that*) to *N*, finally becoming the second argument to *know*. This calculation only considers the most coarse-grained classification (noun, verb, proposition) — as I have emphasized, a purely formal reduction can introduce finer-grained grammatical or lexico-semantic classes (like *at* needing an “argument” which is somehow an expression of place — or time, as in *at noon*). Just as useful, however, may be analyses which leave the formal type scaffolding at a very basic level and introduce finer type or type-instance qualifications at a separate stage.

In either case, Parts of Speech are modeled as (somehow analogous to) functions, but the important analogy is that they have *type signatures* which formally resemble functions’. Words with function-like types proxy their corresponding phrase, not because they are necessarily more important or are Dependency “heads”, but because they supply the pivot in the type resolutions which, collectively/sequentially, progress to a propositional culmination. This epistemological telos induces a sequencing on the type resolutions — there is a fixed way that trees collapse — which motivates the selection of function-words to proxy phrases; they are not semantically more consequential, necessarily, but are landmarks in a dynamic figured syntactically as “folding inward” and semantically as a progressive signifying refinement. Phrases are modeled via a “function-like” Parts of Speech along with one or more additional words whose own types match its signature; the type calculations “collapsing” these phrases can mimic semantic simplifications like *many students* to *students*, but here the theory is explicit that the simplification is grammatic and not semantic: the collapse is acknowledged at the level of *types*, not *meanings*. In addition, tree structures can be modeled purely in terms of inter-word relations — as I have proposed here with double-indices — so a type-summary of a sentence’s phrase structure can be notated and analyzed without leaving the Link or Dependency Grammar paradigm.

Figure 2: Dependency-style graph with type annotations



2.2 Three tiers of linguistic type theory

When explaining grammaticality as type-checking — the concordance between function-like signatures and word or phrase “arguments” — types are essentially structural artifacts; their significance lies in the compositional patterns guiding phrases to merge into larger phrases in a well-ordered way — specifically, that the “outermost” expression, canonically the whole sentence, is type-theoretically a proposition. I proposed earlier that sentence-understanding be read as an accretion of detail culminating in a complete idea; type-checking then imposes regulatory guidelines on this accretion, with each constituent phrase being an intermediate stage. Assigning types to phrases presents a formal means of checking that the accretion stays on track to an epistemological telos — that the accumulated detail will eventually cohere into a propositional whole, a trajectory formally captured by the progressive folding-inward of phrase types to a propositional root.

Types themselves are therefore partly structural fiat — they are marks on intermediate processing stages embodying the paradigm that type-checking *captures* the orderliness of how successive cognitive transforms accrue detail toward a propositionally free-standing end-point. At the same time, types also have semantic interpretations; the $N/Prop$ distinction, for example, is motivated by the cognitive difference between nominals and states of affairs as units of reason. Type-theoretic semantics allows the structural paradigm of type-checked resolutions, the tree “folding inward” onto its root, to be merged with a more semantic or conceptual analysis of types qua categories or classifications of meanings (or of units comprising meanings). I have described this merger

at a coarse level of classification, taking broad parts of speech as individual types, but similar methods apply to more fine-grained analysis. By three “tiers” of linguistic organization, I am thinking of different levels of granularity, distinguished by relative scales of resolution, amongst the semantic implications of putative type representations for linguistic phenomena.

From one perspective, grammar is just a most top-level semantics, the primordial Ontological division of language into designations of things or substances (nouns), events or processes (verbs), qualities and attributes (adjectives), and so forth. Further distinctions like count, mass, and plural nouns add semantic precision but arguably remain in the orbit of grammar (singular/plural agreement rules, for example); the question is whether semantic detail gets increasingly fine-grained and somewhere therein lies a “boundary” between syntax and semantics. The mass/count distinction is perhaps a topic in grammar more so than semantics, because its primary manifestation in language is via agreement (*some* wine in a glass; *a* wine that won a prize; *many* wines from Bordeaux). But are the distinctions between natural and constructed objects, or animate and inanimate kinds, or social institutions and natural systems, matters more of grammar or of lexicon? Certainly they engender agreements and propriety which appear similar to grammatic rules. *The tree wants to run away from the dog* sounds wrong — because the verb *want*, suggestive of propositional attitudes, seems incompatible with the nonsentient *tree*. Structurally, the problem with this sentence seems analogous to the flawed *The trees wants to run away*: the latter has incorrect singular/plural linkage, the former has incorrect sentient/nonsentient linkage, so to speak. But does this structural resemblance imply that singular/plural is as much part of semantics as grammar, or

sentient/nonsentient as much part of grammar as semantics? It is true that there are no morphological markers for “sentience” or its absence, at least in English — except perhaps for “it” vs. “him/her” — but is this an accident of English or revealing something deeper?

In effect, type-related observations can be grouped (not necessarily exclusively or exhaustively) into those I will call *macrotypes* — relating mostly to Parts of Speech and the functional treatment of phrases as applicative structures; *mesotypes* — engaged with existential/experiential qualities and “Ontological” classifications like sentient/nonsentient, rigid/nonrigid, and others I have discussed; and *microtypes* — related to lexemes and word-senses. This lexical level can include “microclassification”, or gathering nouns and verbs by the auxiliary prepositions they allow and constructions they participate in (such as, different cases), and especially how through this they compel various spatial and force-dynamic readings; their morphosyntactic resources for describing states of affairs; and, within semantics, when we look toward even more fine-grained classifications of particular word-senses, to reason through contrasts in usage.⁵ Microclasses can point out similarities in mental “pictures” that explain words’ similar behaviors, or study why different senses of one word succeed or fail to be acceptable in particular phrases. There are *stains all over the tablecloth* and *paint splattered all over the tablecloth*, but not (or not as readily) *dishes all over the tablecloth*. While “stains” is count-plural and “paint” is mass-aggregate, they work in similar phrase-structures because both imply extended but not rigid spatial presence; whereas “dishes” can work for this schema only by mentally adjusting to that perspective, spatial construal shifting from visual/perceptual to practical/operational (we might think of dishes “all over” the tablecloth if we have the chore of clearing them). Such observations support microclassification of nouns (and verbs, etc.) via Ontological and spatial/dynamic/configuration criteria.

Type-theoretic semantics can also apply Ontological tropes to unpack the overlapping mesh of word-senses, like *material object* or *place* or *institution*. This mode of analysis is especially well illustrated when competing senses collide in the same sentence. Slightly modifying two examples:⁶

- ▼ (41) The newspaper you are reading is being sued.
- ▼ (42) Liverpool, an important harbor, built new docks.

Both have a mid-sentence shift between senses, which is analyzed in terms of “type coercions”. The interesting detail of this treatment is how it correctly predicts that such coercions are not guaranteed to be accepted:

⁵So, conceiving microclasses similar in spirit to Steven Pinker in Chapter 2 of [?], though I’m not committing to using the term only in the way Pinker uses it. Cf. also [?], which combines a microclass theory I find reminiscent of *The Stuff of Thought* with formal strategies like Unification Grammar.

⁶[10, p. 40] (former) and [23, p. 4] (latter).

- ▼ (43) The newspaper fired the reporter and fell off the table (?).
- ▼ (44) Liverpool beat Tottenham and built new docks (?).

(again, slightly modifying the counter-examples). Type coercions are *possible* but not *inevitable*. Some word-senses “block” certain coercions — that is, certain sense combinations, or juxtapositions, are disallowed. These preliminary, motivating analyses carry to more complex and higher-scale types, like plurals (the plural of a type-coercion works as a type-coercion of the plural, so to speak). As it becomes structurally established that type rules at the simpler levels have correspondents at more complex levels, the use of type notions *per se* (rather than just “word senses” or other classifications) becomes more well-motivated.

Clearly, for example, only certain kinds of agents may have beliefs or desires, so attributing mental states forces us to conceive of their referents in those terms:

- ▼ (45) Liverpool wants to sign a left-footed striker.
- ▼ (46) That newspaper plans to fire its editorial staff.

This *can* be analyzed as “type coercions”; but the type-theoretic machinery should contribute more than just obliquely stating linguistic wisdom, such as maintaining consistent conceptual frames or joining only suitably related word senses. The sense of *sign* as in “employ to play on a sports team” can only be linked to a sense of Liverpool as the Football Club; or *fire* as in “relieve from duty” is only compatible with newspapers as institutions. These dicta can be expressed in multiple ways. But the propagation of classifications (like “inanimate objects” compared to “mental agents”) through complex type structures lends credence to the notion that type-theoretic perspectives are more than just an expository tool; they provide an analytic framework which integrates grammar and semantics, and various scales of linguistic structuration. For instance, we are prepared to accept some examples of dual-framing or frame-switching, like thinking of a newspaper as a physical object and a city government (but we reject other cases, like *Liverpool voted in a new city government and signed a new striker* — purporting to switch from the city to the Football Club). The rules for such juxtapositions appear to reveal a system of types with some parallels to those in formal settings, like computer languages.

In short, “Ontological” types like *institution* or *place* serve in some examples to partition senses of one multi-faceted word. Here they reveal similar cognitive dynamics to reframing-examples like *to the press*, where Ontological criteria (like reading something as a place) are triggered by phrase-scale structure. But there are also interesting contrasts: the *newspaper* and *Liverpool* examples imply that some words have multiple framings which are well-conventionalized; newspaper-as-institution feels less idiomatic and metaphorical than press-as-place. So these examples suggest two “axes” of variation.

First, whether the proper Ontological framing follows from other word-choices (like “fire” in *the newspaper fired the reporter*, which has its own semantic needs), or from morphosyntax (like the locative in *to the press*); and, second, whether triggered framings work by selecting from established word senses or by something more metaphorical. Metaphors like *to the press* do have an element of standardization; but apparently not so much so to be distinct senses: note how *the press* as metaphorical place does not work in general: [?]*at the press*, [?]*near the press* (but *at the newspaper*, *near the newspaper* — imagine two journalists meeting outside the paper’s offices — sound quite reasonable).

The “type coercion” analysis works for mid-sentence frame-shifts; but other examples suggest a more gradual conceptual “blending”. For example, the place/institution dynamic is particularly significant for *restaurant* (whose spatial location is, more so, an intrinsic part of its identity). Being a *place* implies both location and extension; most places are not single points but have an inside where particular kinds of things happen. I am not convinced that restaurant as place and as institution are separate word senses; perhaps, instead, conversations can emphasize one aspect or another, non-exclusively. As I have argued, we need not incorporate all framing effects via “subtypes” (restaurant as either subtype of hypothetical “types of all” places or institutions, respectively). But “placehood”, the Ontological quality of being a place — or analogously being a social institution — identify associations that factor into cognitive frames; types can then be augmented with criteria of tolerating or requiring one association or another. So if “restaurant” is a type, one of its properties is an institutionality that *may* be associated with its instances. In conversation, a restaurant may be talked about as a business or community, foregrounding this dimension. Or (like in asking for directions) its spatial dimension may be foregrounded. The availability of these foregroundings is a feature of a hypothetical restaurant type, whether or not these phenomena are modeled by subtyping or something more sophisticated. The “newspaper” examples suggest how Ontological considerations clearly partition distinct senses marked by properties like objecthood or institutionality (respectively). For “newspaper” the dimensions are less available for foregrounding from a blended construal, than “unblended” by conventional usage; that is why reframings evince a type *coercion* and not a gentler shift of emphasis. The example of *restaurant*, in contrast, shows that competing routes for cognitive framing need not solidify into competing senses, though they trace various paths which dialogs may follow. But both kinds of examples put into evidence an underlying cognitive-Ontological dynamic which has potential type-oriented models.

At the most general level — what I called *macrotype* modeling — a type system recognizes initially only the grammatical backbone of expressions, and then further type nuances can be seen as shadings and interpretations which add substance

to the syntactic form. So in type-theoretical analysis at this more grammatical level, we can still keep the more fine-grained theory in mind: the relation of syntax to semantics is like the relation of a spine to its flesh, which is a somewhat different paradigm than treating syntax as a logical or temporal stage of processing. Instead of a step-by-step algorithm where grammatical parsing is followed by semantic interpretation, the syntax/semantics interface can be seen as more analogous to stimulus-and-response: observation that a certain grammatical configuration appears to hold, in the present language artifact, triggers a marshaling of conceptual and cognitive resources so that the syntactic backbone can be filled in. Perhaps a useful metaphor is grammar as gravitation, or the structure of a gravitational field, and semantics is like the accretion of matter through the interplay of multiple gravitational centers and orbits. For this analogy, imagine typed lambda reductions like $Prop \rightarrow N \gg N$ taking the place of gravitational equations; and sentences’ grammatical spine taking the place of curvature pulling mass into a planetary center.

As I have argued, sentences’ progression toward complete ideas can be assessed more semantically — accretion of conceptual detail — or more syntactically, in terms of regulated type resolutions pulling in from a tree’s leaves to its root. The latter model is a kind of schematic outline of the former, marking signposts in the accretion process rather like a meetings’ agenda. Type theory allows points in conceptual accretion to be selected — corresponding to nested phrases — where type-checking signals that the accretion is progressing in an orderly fashion. Or, more precisely, type-checking acts as a window on a cognitive process; phrasal units are like periodic gaps in a construction wall allowing us to reconstruct interpretive processes, and the possibility of certain linguistic elements being assigned types marks the points where such windows are possible. So type theory can impose a formal paradigm on our assessment of sentence structure, but at the cost of sampling only discrete steps of an unfolding completion toward understanding. In practice, this discrete analysis should be supplemented with a more holistic and interpretive paradigm, which explores — perhaps speculatively, without demanding thorough formalization — the gaps between the formalizable windows. I will transition toward this style of analysis in the next section.

3 Gaps in Truth-Theoretic Semantics

I take as a given that typical sentences have a propositional core, against which they take a performative stance (which can be outright assertion, or else asserting speakers’ more complex propositional attitudes). I would further say that *truth-theoretic* semantics, in particular, is organized around

this propositional content as the core target of linguistic analysis. I am thinking of truth-theoretic semantics in a broad sense, perhaps the most influential paradigm in the Philosophy of Language and by extension philosophy and linguistics in general (not to mention Computer Science and Artificial Intelligence research). The most notable counter-paradigm is Cognitive Linguistics; consider George Lakoff and Mark Johnson's extended critique of truth-theoretic paradigms in *The Embodied Mind*. Adherents of the latter perspective need not dispute the logical substance of language artifacts' propositional content, but tend to direct theoretical attention not to the nature of propositional content itself, but to the cognitive processes through which this content is understood.

As I argued earlier, many sentences do not simplistically reproduce the logical structure of their propositional content, so models of that structure are only tangentially relevant to analysis on the language side. This is why we need distinct analyses, beyond a mere logical gloss, covering the interpretive steps leading to holistic sentence-understanding. This section will consider several cognitive and pragmatic themes moving toward a general theory of this phis phenomenon.

3.1 *Enaction and Illocutionary Force*

I will start by reviewing illocutionary pragmatics, to identify some of the contextual and interpretive transformations that pertain to mapping surface language to propositional contents. My point is to establish what should be a common theory of logicity that can be shared by both critics and defenders of "truth-theoretic" paradigms, on which basis their legitimate disputes can be investigated.

Many linguists (on both sides, I would say, of my central truth-theoretic pro/con), seem to analyze hedges like "could you please" as merely dressing over crude commands: we don't want to come across as giving people orders, but sometimes we do intend to ask people to do specific things. As a result, we feel obliged to couch the request in conversational gestures that signal our awareness of how bald commands may lie outside the conversational norms. These ritualistic "could you please"-like gestures may have metalinguistic content, but — so the theory goes — they do not *semantically* alter the speech-act's directive nature.

The problem with this analysis is that sometimes directive and "inquisitive" dimensions can overlap:

- ▼ (47) Do you have almond milk?
- ▼ (48) Can you get MsNBC on your TV?
- ▼ (49) This isn't a screw-cap bottle: I need a corkscrew.

These *can* be read as bare directives, and would be interpreted as such if the hearer believed the speaker already knew that

yes, he has almond milk, and yes, he gets MsNBC. In (49), if both parties know there's one corkscrew in the house, the statement implies a directive to fetch *that* corkscrew. But, equally, (47)-(49) can *also* be read as bare questions with no implicature: say, as fans of almond milk and MsNBC endorsing those selections, or pointing out that opening the bottle will need *some* corkscrew. And, meanwhile, (47)-(49) can *also* be read as a mixture of the two, as if people expressed themselves like this:

- ▼ (50) I think the window is open, can you close it?
- ▼ (51) I see you have almond milk, can I have some?
- ▼ (52) If you get MsNBC, can you turn on Rachel Maddow?
- ▼ (53) If there is a corkscrew in the house, can you get it?

I think the mixed case is the most prototypical, and pure directives or inquiries should be treated as degenerate structures where either directive or inquisitive content has dropped out. After all, even a dictatorial command includes the implicit assumption that the order both makes sense and is not impossible. On the other hand, we don't ask questions for no reason: "do you have almond milk" may be a suggestion rather than a request, but it still carries an implicature (e.g., that the addressee *should* get almond milk).

Ordinary requests carry the assumption that addressees can follow through without undue inconvenience, which includes a package of assumptions about both what is currently the case and what is possible. "Close the window" only has literal force if the window is open. So, when making a request, speakers have to signal that they recognize the request involves certain assumptions and are rational enough to accept modifications of these assumptions in lieu of literal compliance. This is why interrogative forms like "can you" or "could you" are both semantically nontrivial and metadiscursively polite: they leave open the possibility of subsequent discourse framing the original request just as a belief-assertion. Developments like *can you open the window — no, it's closed* are not ruled out. At the same time, interrogative forms connote that the speaker assumes the addressees can fulfill the request without great effort: an implicit assumption is that they *can* and also *are willing* to satisfy the directive. This is an assumption, not a presumption: the speaker would seem like a bully if he acted as if he gave no thought to his demands being too much of an imposition — as if he were taking the answer to "can you" questions for granted. This is another reason why requests should be framed as questions. So, in short, "commands" are framed as questions because the speaker literally does not know for sure whether the command is possible; given this uncertainty a command *is* a question, and the interrogative form is not just a non-semantic exercise in politesse.

Sometimes the link between directives and belief assertions is made explicit. A common pattern is to use *I believe* or *I believe that* as an implicature analogous to interrogatives:

- ▼ (54) I believe you have a reservation for Jones?
- ▼ (55) I believe this is the customer service desk?
- ▼ (56) I believe we ordered a second basket of garlic bread?
- ▼ (57) I believe you can help me find computer accessories in this section?

These speakers are indirectly signaling what they want someone to do by openly stating the requisite assumptions — *I believe you can* in place of *can you?*. The implication is that such assumptions translate clearly to a subsequent course of action — the guest who *does* have that reservation should be checked in; the cashier who *can* help a customer find accessories should do so. But underlying these performances is recognition that illocutionary force is tied to background assumptions, and conversants are reacting to the propositional content of those assumptions as well as the force itself. If I *do* close the window I am not only fulfilling the request but also confirming that the window *could* be closed (a piece of information that may become relevant in the future).

In sum, when we engage pragmatically with other language-users, we tend to do so cooperatively, sensitive to what they wish to achieve with language as well as to the propositional details of their discourse. But this often means that I have to interpret propositional content in light of contexts and implicatures. Note that both of these are possible:

- ▼ (58) Do you have any milk?
- ▼ (59) Yes, we have almond milk.
- ▼ (60) No, we have almond milk.

A request for milk in a vegan restaurant could plausibly be interpreted as a request for a vegan milk-substitute. So the concept *milk* in that context may actually be interpreted as the concept *vegan milk*. Responding to the force of speech-acts compels me to treat them as not *wholly* illocutionary — they are in part statements of belief (like ordinary assertions). One reason I need to adopt an epistemic (and not just obligatory) attitude to illocutionary acts is that I need to clarify what meanings the speaker intends, which depends on what roles she is assigning to constituent concepts.

Suppose my friend says this, before and after:

- ▼ (61) Can you put some almond milk in my coffee?
- ▼ (62) Is there milk in this coffee?

Between (61) and (62) I do put almond milk in his coffee and affirm “yes” to (62). I feel it proper to read (62)’s “milk” as really meaning “almond milk”, in light of (61). Actually I should be *less* inclined to say “yes” if (maybe as a prank) someone had instead put real (cow) milk in the coffee. In responding to his question I mentally substitute what he almost certainly *meant* for how (taken out of context) (62) would usually be interpreted. In this current dialog, the

milk concept not only includes vegan milks, apparently, but *excludes* actual milk.

It seems — on the evidence of cases like this one — as if when we are dealing with illocutionary force we are obliged to subject what we hear to extra interpretation, rather than resting only within “literal” meanings of sentences, conventionally understood. This point is worth emphasizing because it complicates our attempts to link illocution with propositional content. Suppose grandma asks us to close the kitchen window. Each of these are plausible and basically polite responses:

- ▼ (63) It’s not open, but there’s still some cold air coming through the cracks.
- ▼ (64) It’s not open, but I closed the window in the bedroom.
- ▼ (65) I can’t — it’s stuck.

In each case I have not fulfilled her request vis-à-vis its literal meaning, but I *have* acted benevolently in terms of conversational maxims.

Part of reading propositional content is syncing our conceptual schemas with our fellow conversants. The illocutionary dimension of a request like *can I have some milk?* makes this interpretation especially important, because the addressee wants to make a good-faith effort to cooperate with the pragmatic intent of the speech-act. But cooperation requires the cooperating parties’ conceptual schemas to be properly aligned. I therefore have to suspend the illocutionary force of a directive temporarily and treat it as locutionary statement of belief, interpret its apparent conceptual underpinnings in that mode, and then add the illocutionary force back in: if I brought *real* milk to a vegan customer who asked for “milk” I would be *un-cooperative*.

The upshot is that conversational implicatures help us contextualize the conceptual negotiations that guarantee our grasping the correct propositional contents, and vice-versa. This means that propositionality is woven throughout both assertive and all other modes of language, but it also means that propositional content can be indecipherable without a detailed picture of the current context (including illocutionary content). The propositional content of, say, *there is milk in this coffee* has to be judged sensitive to contexts like *milk* meaning *vegan milk* — and this propagates from a direct propositional to any propositional attitudes which may be directed towards it, including requests like *please put milk in this coffee*.

Suppose the grandkids close grandma’s bedroom window when she asks them to close the kitchen window. The propositional content at the core of grandma’s request is that the kitchen window be closed; the content attached to it is an unstated belief that this window is open. Thus, the truth-conditions satisfying her implicit understanding would be that the kitchen window went from being open to being closed. As it happens, that window is already closed. So the truth-

conditions that would satisfy grandma’s initial belief-state do not obtain — her beliefs are false — but the truth conditions satisfying her desired result *do* obtain. The window *is* closed. Yet the grandkids should not thereby assume that her request has been properly responded to; it is more polite to guess at the motivation behind the request, e.g., that she felt a draft of cold air. In short, they should look outside the truth conditions of her original request taken literally, and *interpret* her request, finding different content with different truth-conditions that are both consistent with fact and address whatever pragmatic goals grandma had when making her request. They might infer her goal is to prevent an uncomfortable draft, and so a reasonable “substitute content” is the proposition that *some* window is open, and they should close *that* one.

So the grandkids should reason as if translating between these two implied meanings:

- ▼ (66) I believe the kitchen window is open — please close it!
- ▼ (67) I believe some window is open — please close it!

They have to revise the simplest reading of the implicit propositional content of grandma’s *actual* request, because the actual request is inconsistent with pertinent facts. In short, they feel obliged to explore propositional alternatives so as to find an alternative, implicit request whose propositional content *is* consistent with fact and also meets the original request’s illocutionary force cooperatively.

In essence, we need to express a requester’s desire as itself, in its totality, a specific propositional content, thinking to ourselves (or even saying to others) things like

- ▼ (68) Grandma wants us to close the window.
- ▼ (69) He wants a bottle opener.

But to respond politely we need to modify the parse of their requests to capture the “essential” content:

- ▼ (70) Grandma wants us to eliminate the cold draft.
- ▼ (71) He wants something to open that bottle.

We have to read outside the literal interpretation of what they are saying. This re-reading is something that may be appropriate to do with respect to other forms of speech also; but our conversational responsibility to infer some unstated content is especially pronounced when we are responding to an explicit request for something.

Certainly, in many cases, meanings are not literal. But how then do we understand what people are saying? Trying to formulate a not-entirely-haphazard account of this process, we can speculate that interpreting what someone is “really” saying involves systematically mapping their apparent concepts and references to some superimposed inventory designed to mitigate false beliefs or conceptual misalignments among

language users in some context. That means, we are looking for mappings like *milk* to *almond milk* in (72) from a vegan restaurant, or *kitchen window* to *bedroom window* in (73) if it is the latter that is open:

- ▼ (72) Can I have some milk?
- ▼ (73) Can you close the kitchen window?

The point of these “mappings” is that they preserve the possibility of modeling the *original* propositional content by identifying truth conditions for that content to be satisfied.

A *literal* truth-condition model doesn’t work in cases like (72) and (73): the diner’s request is *not* satisfied if it is the case that there is now (real) milk in her coffee; and grandma’s request is not necessarily satisfied if it is the case that the kitchen window is closed. The proposition “the kitchen window is closed” only bears on grandma’s utterance insofar as she believes that this window is open and causing a draft. So if we want to interpret the underlying locutionary content of (72) and (73) truth-theoretically, we need to map the literal concepts appearing in these sentences to an appropriate translation, a kind of “coordinate transformation” that can map concepts onto others, like milk/almond milk and kitchen window/bedroom window.

In sum, a theory of sentences’ logical nexus can only be complete with some model of discursive context *structured in such a way* that we can represent the interpretations and concept-transforms internal to parsing sentences to their propositional core. I will now consider what such a “theory of context” might look like.

3.2 The co-framing system and the doxa system

Illocutionary acts expressly signify our desire for something to change in our environment (with the help of our addressees), but similar implications of pragmatic desire are evident even when sentences are more directly assertorial, or less directly illocutionary. Compare between:

- ▼ (74) Remember that wine we tasted on the Niagara Peninsula last summer? Can you find it in our local liquor store?
- ▼ (75) Remember that wine we tasted on the Niagara Peninsula last summer? What varietal was that again?

The first sentence in each pair attempts to establish a common frame of reference between addresser and addressee — it does not, in and of itself, request any practical (extramental) action. The second sentence in (74) *can* be read as requesting that the addressee buy a bottle, though an alternate interpretation is to learn for *future reference* whether someone *could* buy that bottle. The second sentence in (75) carries no directive

implicature at all, at least with any directness; it asks for more information.

Despite these variations, it seems reasonable to say that language is always performed in an overarching setting where concrete (extralinguistic) activity will *eventually* take place. If in (75) I intend to recommend that grape variety to a friend, I may not be making a direct request of him, but I *am* proposing an eventual action that he might take. If in (74) I am not issuing a directive, I am however establishing (and reserving the future possibility) that such a directive would be reasonable. As a result, some extralinguistic state change seems to be lurking behind the linguistic content: I want my friend to go from having never tasted that varietal to having tasted it. Or I want to go from not having a bottle of that wine to having one. Or, if I do not want these things at the moment, I want to confirm intellectually that these wishes are plausible. We seem to use language to set up the interpersonal understandings needed to *eventually* engage in (usually collective) practical activity, which means effectuating some (extralinguistic) change.

That is, most expressions are not direct requests or suggestions of the “close the window” or “let’s get some wine” variety, but they are stitches in the thread of coordinated human actions. Often however we use language to *prepare*, *negotiate*, and *decide upon* joint actions. We may have a *holistic* sense that meanings orbit around extralinguistic and extramental state-change, but at the level of particular sentences most changes that occur, or are proposed, tend to be changes in our conceptualization of situations. Accordingly, we can pursue a semantic theory based on *change of state* if we accept that such changes run the gambit from changes *internal* to language — to conversants’ appraisal of dialogic context — to changes effectuated by human activity inspired by language. Dialogs themselves change: the first sentences in (74) and (75) modify the discursive frame so that, for example, a particular wine becomes available as the anaphoric target for *that* and *that wine* — and also, metonymically, *that varietal*, *that grape*, *that winery*. Conceptual frames can change: if we are discussing a visit to Ontario and I mention one specific winery, one effect is to (insofar as the conversation follows my lead) refigure our joint framing to something narrower and more granular than the prior frame (but still contained in it; I am not changing the subject entirely). We can pull a frame out as well as in — e.g., switch from talking about one winery visit to the whole trip, or one Leafs game to the entire season. Moreover, our beliefs can change/evolve: if you tell me the wine was Cabernet Franc, I have that piece of info in my arsenal that I did not have before.

So I will argue and assume in this paper that linguistic meanings are grounded in state-changes, with the stipulation that the “register” where the changes occur can vary over several cognitive and extramental options: actual change in

our environment (the window closed, milk in the coffee, the bottle opened); changes to the dialog structure (for anaphoric references, pronoun resolution, metalinguistic cues like *can you say that again*, etc.); changes to conceptual framings (zoom in, zoom out, add detail); changes to beliefs. Each of these kinds of changes deserve their own analysis, but we can imagine the totality of such analyses forming an umbrella theory of meanings.

During the course of a conversation — and indeed of any structured cognitive activity — we maintain conceptual frames representing relevant information; what other people know or believe; what are our goals and plans (individually and collectively); and so forth. We update these frames periodically, and use language to compel others to modify their frames in ways that we can (to some approximation) anticipate and encode in linguistic structure.

In the simplest case, we can effectuate changes in others’ frames by making assertions they are likely to believe to be true (assuming they deem us reliable). In general, it is impossible to extricate the explicit content of the relevant speech-acts from the relevant cognitive, linguistic, and real-world situational contexts:

- ▼ (76) That wine was a Cabernet Franc.
- ▼ (77) Those dogs are my neighbor’s. They are very sweet.

Although there is a determinate propositional content being asserted and although there is no propositional attitude other than bald assertion to complicate the pragmatics, still the actual words depend on addressees drawing from the dialogic context in accord with how I expect them to (as manifest in open-ended expressions like *that wine*, *those dogs*, *they*). Moreover, the open-ended components can refer outward in different “registers”: in *that wine* I may be referencing a concept previously established in the conversation, while *those dogs* may refer to pets we saw or heard but had not previously talked about. Of course, the scenarios could be reversed: I could introduce *that wine* into the conversation by gesturing to a bottle you had not noticed before, and refer via *those dogs* to animals you have never seen or heard but had talked about, or heard talk about, in the recent past. These dialog steps need to be resolved via a mixture of linguistic and extra-linguistic cues: surface-level language is not always clear as to whether referring expressions are to work “deictically” (drawing content from the ambient context, signified by gestures, rather than from any linguistic meaning proper), “discursively” (referring within chains of dialog, e.g. anaphora), or “descriptively” (using purely semantic means to establish a designation, like “my next-door neighbor’s dogs” or “Inniskillin Cabernet Franc Icewine 2015”).

Let’s agree to call the set of entities sufficiently relevant to a discourse or conversation context the *ledger*. By “sufficiently relevant” I mean whatever is already established in a discourse

so it can be referenced with something less than full definite description (and without the aid of extralinguistic gestures). I assume that gestures and/or descriptions are communicative acts which “add” to the ledger. The purely linguistic case — let’s say, *descriptive additions* — can themselves be distinguished by their level of grounding in the current context. A description can be “definitive” in a specific situation without being a *definite description* in Russell’s sense (see “that wine we tasted last summer”).

So, descriptive additions to the ledger are one kind of semantic side-effect: we can change the ledger via language acts. I will similarly dub another facet of cognitive-linguistic frames as a *lens*: the idea that in conversation we can “zoom” attention in and out and move it around in time. “That wine we tasted last summer in Ontario” both modifies the *ledger* (adding a new referent for convenient designation) and might alter the *lens*: potentially compelling subsequent conversation to focus on that time and/or place. Finally, I will identify a class of frame-modifications which do directly involve propositional content: the capacity for language to promote shared beliefs between people whose cognitive frames are in the proper resonance, by adding details to conceptual pictures already established: *those dogs are Staffordshires, that wine is Cabernet Franc, we have almond milk*, etc.

For sake of discussion, I will call this latter part of the “active” cognitive frame, for some discussion — the part concerning shared beliefs or asserted facts — the *doxa inventory*. This “database”-like repository stands alongside the “ledger” and “lens” to track propositional content asserted, collectively established, or already considered as background knowledge, vis-à-vis some discourse. Manipulations of the lens and ledger allow speakers to designate (using referential cues that could be ambiguous out-of-context) propositional contents which they wish to add to the “doxa inventory”. I’ll also say that modifying this inventory *can* be done through language, but participants in a discourse are entitled to assume that everyone formulates certain beliefs which are observationally obvious, and can therefore be linguistically presupposed rather than reported (the likes of that a traffic light is red, or a train has pulled into a station, or that it’s raining).

So, I will assume that the machinery of frames is cognitive, not just linguistic. We have analogous faculties for “refocusing” attention and adding conceptual details via interaction with our environment, both alone and with others, and both via language and via other means. Some aspects of *linguistic* cognitive framing — like the “ledger” of referents previously established in a conversation — may be of a purely linguistic character, but these are the exception rather than the rule. In the typical case we have a latent ability to direct attention and form beliefs by direct observation *or* by accepting others’ reports as proxies for direct observation.

When we are told that two dogs are male, for instance, we

may not perceptually encounter the dogs but we understand what sorts of preceptual disclosures could serve as motivation for someone believing that idea. We therefore assume that such belief was initially warranted by observation and subsequently got passed through a chain of language-acts whose warrants are rooted in the perceived credibility of the speaker. Internal to this process is our prior knowledge of the parameters for judging statements like *this dog is male* observationally.

True, sometimes such observational warrants are less on display. If I had never heard of Staffies (Staffordshire pit bulls), I would be fuzzier about observational warrants and could end up in conversations like:

- ▼ (78) Those dogs are Staffordshires.
- ▼ (79) What’s a Staffordshire?
- ▼ (80) It’s a breed of dog.

Here I still don’t really have a picture of what it is like to tell observationally that a dog is a Staffordshire. There may not be any visual cues — at least none I know of — which announce to the world that some dog’s a Staffy (compared to those announcing that it is male, say). But insofar as I am acquainted with the concept *dog breed*, I also understand the general pattern of these observations. For instance I may know breeds like poodles or huskies and be able to identify *these* by distinctive visual cues. I also understand that dogs’ parentage is often documented, allowing informed parties to know their breeds via those of their forebearers. That is, I am familiar with how beliefs about breeds are formed based on observation rather than just accepting others’ reports, so I know the extralinguistic epistemology anchoring chains of linguistic reports in this area to originating observations — even if I cannot in this case initiate such a chain myself.

My overall point is that language enables us to formulate beliefs based on the beliefs of others, but this is possible because we also realize what it is like to formulate *our own* beliefs, and envision that sort of practice at the origin of reports that later get circulated via language. If we can’t sufficiently picture the originating observations, we don’t feel like we are grasping the linguistic simulacrum of those reports with enough substance. If I never learn what Staffordshire is, an assertion that some dogs are Staffordshires has no real meaning for me — even if I trust the asserter and do indeed thereby believe that the dogs are Staffordshires. Notice that merely knowing Staffordshire is a breed of dog does not expand my conceptual repertoire very much — it does not tell me how to recognize a Staffordshire or what I can do with the knowledge that a dog is one (it cannot, for instance, help me anticipate his behavior). Nevertheless even (only) knowing that Staffordshire is a breed of dog seems to fundamentally change the status of sentences like *those dogs are Staffies* for me: I do not *have* the conceptual machinery to exploit

that knowledge, but I understand what *sort* of machinery is involved.

In short, the *linguistic* meaning of concepts is tightly bound to how concepts factor in perceptual observations anterior to linguistic articulation. As a result, during any episode wherein conversants use language to compel others' beliefs, an intrinsic dimension of the unfolding conversation is that people will form their own (extralinguistic) beliefs — and can also imagine themselves in the role of originating the reports they hear via language, whether or not they can actually test out the reports by their own observations.

This extralinguistic epistemic capacity is clearly exploited by the form of language itself. If a tasting organizer hands me a glass and says “This is Syrah”, she clearly expects me to infer that I should take the glass from her and taste the wine (and know that the glass contains wine, etc.). These conventions may be *mediated* by language — we are more likely to understand “unspoken” norms by asking questions, until we gain enough literacy in the relevant practical domain to understand unspoken cues and assumptions. But many situational assumptions are extralinguistic because they are (by convention) not explicitly stated, even if they accompany content that *is* explicitly stated. *This is Syrah* accompanied by the gesture of handing me a glass is an indirect invitation for me to drink it (compare to *Please hold this for a second?* or *Please hand this to the man behind you?*).

I bring to every linguistic situation a capacity to make extralinguistic observations, and to understand every utterance in the context of hypothetical extralinguistic observations from which it originates. My conversation peers can use language to trigger these extralinguistic observations. Sometimes the “gap” — the conceptual slot which extralinguistic reasoning is expected to fill — is directly expressed, as in *See the dog over there?*. But elsewhere the “extralinguistic implicature” is more indirect, as in *This is Syrah* and my expected belief that I should take and taste from the glass. But in any case the phenomenon of triggering these extralinguistic observation is one form of linguistic “side effect”, initiating a change in my overall conceptualization of a situation by compelling me to augment beliefs with new observations.

All told, then, the language which is presented to me has the effect of initiating changes in what I believe — partly via signifying propositional content that I could take on faith, but partly also via directing my attention and my interpretive dispositions to guide me towards extralinguistic observations. Here I will argue that side-effects like these are not side-effects of linguistic meaning, but are in some sense *constitutive* of meaning.

3.3 The Illogic of Syntax

Let us agree that — beneath surface-level co-framing complexity — many language acts have a transparent content as “doxa” that gets conveyed between people with sufficiently resonant cognitive frames. So *in the overall course of communication* we have propositional contents that converge among discourse partners, suspended between the various cognitive and pragmatic units which contextualize a given, unfolding dialog. There is in short a *holistic* mapping between units of discourse and “units” of propositionality, or “doxa”. This general observation leaves unstated, however, *how* language elements map to corresponding doxic particulars. I will argue that focusing on the *logical structures* of propositions can lead us astray if we seek to find concordant formations on the language side.

Consider our attempts to close grandma’s kitchen window. My analysis related to conceptual “transforms” assumed that we can find, substituting for *literal* propositional content, some *other* (representation of a) proposition that fulfills a speaker’s unstated “real” meaning. Sometimes this makes sense: the proposition “that the *bedroom* window is closed” can neatly, if the facts warrant, play the role of the proposition that *the kitchen window is closed*. But we can run the example differently: there may be *no* window open, but instead a draft caused by non-airtight windows (grandma might ask us to put towels by the cracks). Maybe there is no draft at all (if grandma is cold, we can fetch her a sweater). Instead of a single transform, we need a system of potential transforms that can adapt to the facts as we discover them. Pragmatically, the underlying problem is that *grandma is cold*. We can address this — if we want to faithfully respond to her request, playing the role of cooperative conversation partners (and grandkids) — via a matrix of logical possibilities:

- ▼ (81) If the kitchen window is closed, we can see if other windows are open.
- ▼ (82) If no windows are open, we can see if there is a draft through the window-cracks.
- ▼ (83) If there is no draft, we can ask if she wants a sweater.

This is still a logical process: starting from an acknowledged proposition (grandma is cold) we entertain various other propositional possibilities, trying to rationally determine what pragmas we should enact to alter that case (viz., to instead make true the proposition that *grandma is warm*). Here we are not just testing possibilities against fact, but strategically acting to modify some facts in our environment.

But the kind of reasoning involved here is not logical reasoning per se: abstract logic does not tell us to check the bedroom window if the kitchen window is closed, or to check for gaps and cracks if all windows are closed. This all solicits practical, domain-specific knowledge (about windows, air, weather, and

houses). Yet we are still deploying our practical knowledge in logical ways — there is a logical structure underpinning grandma’s request and our response to it. In sum: we (the grandkids) are equipped with some practical knowledge about houses and a faculty to logically utilize this knowledge to solve the stated problem, reading beyond the *explicit* form of grandma’s discourse. We use a combination of logic and background knowledge to reinterpret the discourse as needed. By making a request, grandma is not expressing one attitude to one proposition, so much as *initiating a process*. This is why it would be impolite to simply do no more if the kitchen window is closed: our conversational responsibility is to enact a process trying to redress grandma’s discomfort, not to entertain the truth of any one proposition.

For all that, there is still an overarching logical structure here that language clearly marshals. We read past grandma’s explicit request to infer what she is “really saying” — e.g., *that she is cold* — but we still regard her speech act in terms of its (now indirect) propositional content. However, notice how our ascertaining this content only one step toward legitimate understanding of the original speech-act (even accounting for its illocutionary dimensions). The doxa are *factors* in understanding but, given these cases, are not straightforward *designata* of linguistic compounds. This implies a critique of truth-theoretic paradigms from a semiotic and compositional perspective: language is not *composed* to convey doxa through semantic reference and grammatic form internally (without the mediation of extralinguistic cognition); propositional content does not *fall out* of syntax and semantics. I will expand on this critique in the next section.

To summarize my current arguments, then, I believe that most sentences have an accompanying propositional content, and that during conversations we interpret this content as a factor in sentence meanings, becoming aware of what our partners believe, desire, or inquire to be the case. We retain this awareness in a cumulative model of conversational context — a “doxa inventory” — alongside other referential and deictic axes establishing each dialogic setting. Essentially, I grant that this doxic layer is central to linguistic performance in general — but given this very centrality I will argue that the logical substratum of language cannot be *separated* from the totality of syntactic, semantic, and pragmatic processing such that models based on formal logic could be curated in isolation from the overarching interconnectedness of language as a cognitive system.

As I understand it, a non-trivial truth-theoretic semantics requires more than a holistic association between sentences and propositional content: it requires that this association be established *by linguistic means* and *on linguistic grounds* (syntax, semantics, pragmatics). I will present several arguments against this possibility, in the general cases — that is, against the possibility that for *typical* sentences we can analyze syntac-

tic form through the lens of the logical structure of propositions signified via a sentence; or analyze natural-language semantics through a logically well-structured semantics of propositions. I will emphasize two issues: first, that the architecture of linguistic performances *does not*, in the general case, *recapitulate propositional structure*; and, second, that language acts work through gaps in logical specificity that complicate how we should theorize the triangular relation between surface language, propositional content, and side-effect meanings.

Since it is widely understood that the essence of language is compositionality, the clearest path to a truth-theoretic semantics would be via the “syntax of semantics”: a theory of how language designates propositional content by emulating or iconifying propositional structure in its own structure (i.e., in grammar). This would be a theory of how linguistic connectives reciprocate logical connectives, phrase hierarchies reconstruct propositional compounds, etc. It would be the kind of theory motivated by cases like

- ▼ (84) This wine is a young Syrah.
- ▼ (85) My cousin adopted one of my neighbor’s dog’s puppies.

where morphosyntactic form — possessives, adjective/noun links — seems to transparently recapitulate predicate relations. Thus the wine is young *and* Syrah, and the puppy if the offspring of a dog who is the pet of someone who is the neighbor of the speaker. These are well-established logical forms: predicate conjunction, here; the chaining of predicate operators to form new operators, there. Such are embedded in language lexically as well as grammatically: the conjunction of husband and “former, of a prior time” yields ex-husband; a parent’s sibling’s daughter is a cousin.

The ininteresting question is to what extent “morphosyntax recapitulates predicate structure” holds in general cases. This can be considered by examining the logical structure of reported assertions and then the structures via which they are expressed in language. I’ll carry out this exercise vis-à-vis several sentences, such as these (supplementing my earlier, more preliminary discussion of (29)-(32):

- ▼ (86) The majority of students polled were opposed to tuition increases.
- ▼ (87) Most of the students expressed disappointment about tuition increases.
- ▼ (88) Many students have protested the tuition increases.

There are several logically significant elements here that seem correspondingly expressed in linguistic elements — that is, to have some model in both prelinguistic predicate structure and in, in consort, semantic or syntactic principles. All three of (86)-(88) have similar but not identical meanings, and the differences are manifest both propositionally and linguistically (aside from the specific superficial fact that they are not the

same sentence). I will review the propositional differences first, then the linguistic ones.

One obvious predicative contrast is that (86) and (87) ascribes a certain *quality* to students (e.g., disappointment), whereas (87) and (88) indicate *events*. As such the different forms capture the contrast between “bearing quality *Q*” and “doing or having done action *A*”: the former a predication and the latter an event-report. In the case of (87), both forms are available because we can infer from *expressing* disappointment to *having* disappointment. There may be logics that would map one to the other, but let’s assume we can analyze language with a logic expressive enough to distinguish events from quality-instantiations.

Other logical forms evident here involve how the subject noun-phrases are constructed. “A majority” and “many” imply a multiplicity which is within some second multiplicity, and numerically significant there. The sentences differ in terms of how the multiplicities are circumscribed. In the case of *students polled*, an extra determinant is provided, to construct the set of students forming the predicate base: we are not talking about students in general or (necessarily) students at one school, but specifically students who participated in a poll.

Interrelated with these effects are how the *tuition increases* are figured. Using the explicit definite article suggests that there is *some specific* tuition hike policy raising students’ ire. This would also favor a reading where “students” refers collectively to those at a particular school, who would be directly affected by the hikes. The *absence* of an article on “tuition increases” in (87) leaves open an interpretation that the students are not opining on some specific policy, but on the idea of hikes in general.

Such full details are not explicitly laid out in the sentences, but it is entirely possible that they are clear in context. Let’s take as given that, in at least some cases where they would occur, the sentences have a basically pristine logical structure given the proper contextual framing — context-dependency, in and of itself, does not weaken our sense of language’s logicity. In particular, the kind of structures constituting the sentences’ precise content — the details that seem context-dependent — have bona fide logical interpretations. For example, we can consider whether students are responding to *specific* tuition hikes or to hikes in general. We can consider whether the objectionable hikes have already happened or are just proposed. Context presumably identifies whether “students” are drawn from one school, one governmental jurisdiction, or some other aggregating criteria (like, all those who took a poll). Context can also determine whether aggregation is more set- or type-based, more extensional or intensional. In (86)-(88) the implication is that we should read “students” more as a set or collection, but variants like *students hate tuition hikes* operates more at the level of students as a *type*. In “stu-

dents polled” there is a familiar pattern of referencing a set by marrying a type (students in general) with a descriptive designation (e.g., those taking a specific poll). The wording of (86) does not mandate that *only* students took the poll; it does however employ a type as a kind of operator on a set: of those who took the poll, focus on students in particular.

These are all essentially logical structures and can be used to model the propositional content carried by the sentences — their “doxa”. We have operators and distinctions like past/future, set/type, single/multiple, subset/superset, and abstract/concrete comparisons like tuition hikes *qua* idea vs. *fait accompli*. A logical system could certainly model these distinctions and accordingly capture the semantic differences between (86)-(88). So such details are all still consistent with a truth-theoretic paradigm, although we have to consider how linguistic form actually conveys the propositional forms carved out via these distinctions.

Ok, then, to the linguistic side. My first observation is that some logically salient structures have fairly clear analogs in the linguistic structure. For instance, the logical operator for deriving a set from criteria of “student” merged with “taking a poll” is brought forth by the verb-as-adjective formulation *students polled*. Subset/superset arrangements are latent as lexical norms in senses like *many* and *majority*. Concrete/abstract and past/future distinctions are alluded to by the presence or absence of a definite article. So “*the* tuition increases” connotes that the hikes have already occurred, or at least been approved or proposed, in the past relative to the “enunciatory present” (as well as that they are a concrete policy, not just the idea), whereas articleless “tuition increases” can be read as referring to future hikes and the idea of hikes in general: past and concrete tends to contrast with future and abstract.

A wider range of logical structures can be considered by subtly varying the discourse, like:

- ▼ (89) Most students oppose the tuition increase.
- ▼ (90) Most students oppose a tuition increase.

These show the possibility of *increase* being singular (which would tend to imply it refers to a concrete policy, some *specific* increase), although in (90) the *indefinite* article *may* connote a discussion about hikes in general.

But maybe not; cases like these are perfectly plausible:

- ▼ (91) Today the state university system announced plans to raise tuition by at least 10%. Most students oppose a tuition increase.
- ▼ (92) Colleges all over the country, facing rising costs, have had to raise tuition, but most students oppose a tuition increase.

In (91) the definite article could also be used, but saying “a

tuition increase” seems to reinforce the idea that while plans were announced, the details are not finalized. And in (92) the plural “increases” could be used, but the indefinite singular connotes the status of tuition hikes as a general phenomenon apart from individual examples — even though the sentence also makes reference to concrete examples. In other words, these morphosyntactic cues are like levers that can fine-tune the logical designation more to abstract or concrete, past or future, as the situation warrants. Again, context should clarify the details. But morphosyntactic forms — e.g., presence or absence of articles (definite or indefinite), and singular/plural — are vehicles for language, through its own forms and rules, to denote propositional-content structures like abstract/concrete and past/future.

So these are my “concession” examples: cases where language structures *do*, in their compound architectonics, signifying propositional contents — and moreover the lexical and morphosyntactic cues (like singular/plural or the choice of articles) drive this language-to-logic mapping in an apparently rule-bound and replicable fashion. These are potential case-studies of how a truth theory of language, without neglecting contextual and semantic subtleties, *could* work: capturing granular semantic constasts via sufficiently nuanced logics, and theorizing word-senses and morphology through the aegis of a structural reduction between surface language and predicate structure. My tactic for critiquing truth-theoretic paradigms is to argue that many sentences *fail* to display a mapping between lexico/morphosyntactic details and predicate structure *in this relatively mechanical fashion*. By pointing out examples where morphosyntax *does* rather seamlessly recapitulate propositional content (e.g. *the tuition hike* plural/definite), we can appreciate the more circuitous hermeneutics for examples I will present wherein the morphosyntax-to-logic translation, while present, is not *sui generis*.

Varying the current examples yields cases where logical implications are be more circuitous. For instance, describing students as *disappointed* implies that the disliked hikes have already occurred, whereas phraseology like “students are gearing for a fight” would imply, conversely, that they are still only planned or proposed. The mapping from propositional-content structure to surface language here is less mechanical than, for instance, merely using the definite article on *the tuition increases*. Arguably “disappointment” — rather than just, say, “opposition” — implies a specific timeline and concreteness, an effect analogous to the definite article. The semantic register of “disappointment” bearing this implication is a more speculative path of conceptual resonances, compared to the brute morphosyntactic “the”. There is subtle conceptual calculation behind the scenes in the former case. Nonetheless, it does seem as if via this subtlety linguistic resources are expressing the constituent units of logical forms, like past/future and abstract/concrete.

So, I am arguing (and conceding) that there are units of logical structure that are conveyed by units of linguistic structure, and this is partly how language-expressions can indicate propositional content. The next question is to explore this correspondance compositionally — is there a kind of aggregative, hierarchical order in terms of how “logical modeling elements” fit together, on one side, and linguistic elements fit together, on the other? There is evidence of compositional concordance to a degree, examples of which I have cited. In *students polled*, the compositional structure of the phrase mimics the logical construct — deriving a set (as a predicate base) from a type crossed with some other predicate. Another example is the phraseology *a/the majority of*, which directly nominates a subset/superset relation and so reciprocates a logical quantification (together with a summary of relative size; the same logical structure, but with different ordinal implications, is seen in cases like *a minority of* or *only a few*). Here there is a relatively mechanical translation between propositional structuring elements and linguistic structuring elements.

However, varying the examples — for instance, varying how the subject noun-phrases are conceptualized — points to how the synchrony between propositional and linguistic composition can break down:

- ▼ (93) Student after student came out against the tuition hikes.
- ▼ (94) A substantial number of students have come out against the tuition hikes.
- ▼ (95) The number of students protesting the tuition hikes may soon reach a critical mass.
- ▼ (96) Protests against the tuition hikes may have reached a tipping point.

Each of these sentences says something about a large number of students opposing the hikes. But in each case they bring new conceptual details to the fore, and I will also argue that they do so in a way that deviates from how propositional structures are composed.

First, consider *student after student* as a way of designating *many students*. There is a little more rhetorical flourish here than in, say, *a majority of students*, but this is not just a matter of eloquence (as if the difference were stylistic, not semantic). “Student after student” creates a certain rhetorical effect, suggesting via how it invokes its multiplicity a certain recurring or unfolding phenomenon. One imagines the speaker, time and again, hearing or encountering an angry student. To be sure, there are different kinds of contexts that are consistent with (93): the events could unfold over the course of a single hearing or an entire semester. Context would foreclose some interpretations — but it would do so in any case, even with simpler designations like *majority of students*. What we *can* say is that the speaker’s chosen phraseology cognitively highlight a dimension in the events that carries a certain subjective content, invoking their temporality and repetition.

The phrasing carries an effect of cognitive “zooming in”, each distinct event figured as if temporally inside it; the sense of being tangibly present in the midst of the event is stronger here than in less temporalized language, like “many students”. And then at the same time the temporalized event is situated in the context of many such events, collectively suggesting a recurring presence. The phraseology zooms in and back out again, in the virtual “lens” of our cognitively figuring the discourse presented to us — all in just three or four words. Even if “student after student” is said just for rhetorical effect — which is contextually possible — *how* it stages this effect still introduces a subjective coloring to the report.

Another factor in (93) and (94) is the various possible meanings of “come out against”. This could be read as merely expressing a negative opinion, or as a more public and visible posturing. In fact, a similar dual meaning holds also for “protesting”. Context, again, would dictate whether *protesting* means actual activism or merely voicing displeasure. Nonetheless, the choice of words can shade how we frame situations. To *come out against* connotes expressing disapproval in a public, performative forum, inviting the contrast of inside/outside (the famous example being *come out of the closet* to mean publicly identifying as LGBTQ). Students may not literally be standing outside with a microphone, but — even if the actual situation is just students complaining rather passively — using *come out against* paints the situation in an extra rhetorical hue. The students are expressing the *kind* of anger that can goad someone to make their sentiments known theatrically and confrontationally. Similarly, using “protest” in lieu of, say, “criticize” — whether or not students are actually marching on the quad — impugns to the students a level of anger commensurate with politicized confrontation.

All these sentences are of course *also* compatible with literal rioting in the streets; but for sake of argument let’s imagine (93)-(96) spoken in contexts where the protesting is more like a few comments to a school newspaper and hallway small-talk. The speakers have still chosen to use words whose span of meanings includes the more theatrical readings: “come out against” and “protest” overlap with “complain about” or “oppose”, but they imply greater agency, greater intensity. These lexical choices establish subtle conceptual variations; for instance, to *protest* connotes a greater shade of anger than to *oppose*.

Such conceptual shading is not itself unlogical; one can use more facilely propositional terms to evoke similar shading, “like very angry” or “extremely angry”. However, consider *how* language like (93)-(96) conveys the relevant facts of the matter: there is an observational, in-the-midst-of-things staging at work in these latter sentences that I find missing in the earlier examples. “The majority of” sounds statistical, or clinical; it suggests journalistic reportage, the speaker making an atmospheric effort to sound like someone reporting facts

as established knowledge rather than observing them close-at-hand. By contrast, I find (93)-(96) to be more “novelistic” than “journalistic”. The speaker in these cases is reporting the facts by, in effect, *narrating* them. She is building linguistic constructions that describe propositional content through narrative structure — or, at least, cognitive structures that exemplify and come to the fore in narrative understanding. Saying “a substantial number of students”, for example, rather than just (e.g.) *many* students, employs semantics redolent of “force-dynamics”: the weight of student anger is described as if a “substance”, something with the potency and efficacy of matter.

This theme is also explicit in “critical mass”, and even *tipping point* has material connotations. We can imagine different versions of what lies on the other side of the tipping point — protests go from complaining to activism? The school forced to reverse course? Or, contrariwise, the school “cracking down” on the students (another partly imagistic, partly force-dynamic metaphor)? Whatever the case, language like “critical mass” or “tipping point” is language that carries a structure of story-telling; it tries tie facts together with a narrative coherence. The students’ protests grew more and more strident until ... the protests turned aggressive; or the school dropped its plans; or they won public sympathy; or attracted media attention, etc. Whatever the situation’s details, describing the facts in force-dynamic, storylike, spatialized language (e.g. “come out against”) represents an implicit attempt to report observations or beliefs with the extra fabric and completeness of narrative. It ascribes causal order to how the situation changes (a critical mass of anger could *cause* the school to change its mind). It brings a photographic or cinematic immersion to accounts of events and descriptions: *student after student* and *come out* invite us to grasp the asserted facts by *imagining* situations.

The denouement of my argument is now that these narrative, cinematic, photographic structures of linguistic reportage — signaled by spatialized, storylike, force-dynamic turns of phrase — represent a fundamentally different way of signifying propositional content, even while they *do* (with sufficient contextual grounding) carry propositional content through the folds of the narrative. I don’t dispute that hearers understand logical forms via (93)-(96) similar to those more “journalistically” captured in (86)-(88). Nor do I deny that the richer rhetoric of (93)-(96) play a logical role, capturing granular shades of meaning. My point is rather that the logical picture painted by the latter sentences is drawn via (I’ll say as a kind of suggestive analogy) *narrative structure*.

I argued earlier that elements of propositional structure — for example, the set/type selective operator efficacious in *students polled* — can have relatively clean morphosyntactic manifestation in structural elements in language, like the verb-to-adjective mapping on *polled* (here denoted, in English,

by unusual word position rather than morphology, although the rules would be different in other languages). Given my subsequent analysis, however, I now want to claim that the map between propositional structure and linguistic structure is often much less direct. I'm not arguing that "narrative" constructions lack logical structure, or even that their rhetorical dimension lies outside of logic writ large: on the contrary, I believe that they use narrative effects to communicate granular details which have reasonable logical bases, like degrees of students' anger, or the causative interpretation implied in such phrases as *critical mass*. The rhetorical dimension does not prohibit a reading of (93)-(96) as expressing propositional content — and using rhetorical flourishes to do so.

I believe, however, that *how* they do so unzips any neat alignment between linguistic and propositional structure. Saying that students' protests "may have reached a critical mass" certainly expresses propositional content (e.g., that enough students may now be protesting to effectuate change), but it does so not by mechanically asserting its propositional idea; instead, via a kind of mental imagery which portrays its idea, in some imaginative sense, iconographically. "Critical mass" compels us to read its meaning imagistically; in the present context we are led to actually visualize students protesting *en masse*. Whatever the actual, empirical nature of their protestation, this language paints a picture that serves to the actual situation as an interpretive prototype. This is not only a conceptual image, but a visual one.

Figurative language — even if it is actually metaphorical, like "anger boiling over" — has similar effect. Alongside the analysis of metaphor as "concept blending", persuasively articulated by writers like Gilles Fauconnier and Per Aage Brandt, we should also recognize how metaphor (and other rhetorical effects) introduces into discourse language that invites visual imagery. Sometimes this works by evoking an ambient spatiality (like "come out against") and sometimes by figuring phenomena that fill or occupy space (like "students protesting" — one salience of this language is that we imagine protest as a demonstrative gesture expanding outward, as if space itself were a theater of conflict: protesters arrayed to form long lines, fists splayed upward or forward). There is a kind of visual patterning to these evocations, a kind of semiotic grammar: we can analyze which figurative senses work via connoting "ambient" space or via "filling" space, taking the terms I just used. But the details of such a semiotic are tangential to my point here, which is that the linguistic structures evoking these visual, imagistic, narrative frames are not simply reciprocating propositional structure — even if the narrative frames, via an "iconic" or prototype-like modeling of the actual situation, are effective vehicles for *communicating* propositional structure.

What breaks down here is not propositionality but *compositionality*: the idea that language signifies propositional

content *but also* does so compositionally, where we can break down larger-scale linguistic elements to smaller parts *and* see logical structures mirrored in the parts' combinatory maxims. In the later examples, I have argued that the language signifies propositional content by creating narrative mock-ups. The point of these imagistic frames is not to recapitulate logical structure, but to have a kind of theatrical coherence — to evoke visual and narrative order, an evolving storyline — from which we then understand propositional claims by interpreting the imagined scene. Any propositional signifying in these kinds of cases works through an intermediate stage of narrative visualization, whose structure is holistic more than logically compositional. It relies on our faculties for imaginative reconstruction, which are hereby drafted into our language-processing franchise.

This kind of language, in short, leverages its ability to trigger narrative/visual framing as a cognitive exercise, intermediary to the eventual extraction of propositional content. As such it depends on a cognitive layer of narrative/visual understanding — which, I claim, belongs to a different cognitive register than building logical models of propositional content directly.

In the absence of a compelling analysis of *compositionality* in the structural correspondance between narrative-framed language and logically-ordered propositional content, I consequently think we need a new theory of how the former signifies the latter. My own intuition is that language works by triggering *several different* cognitive subsystems. Some of these hew closely to predicate logic; some are more holistic and narrative/visual. Cognitive processes in the second sense may be informed and refined by language, but they have an extralinguistic and prelinguistic core: we can exercise faculties of narrative imagination without explicit use of language (however much language orders our imaginations by entrenching some concepts more than others, via lexical reinforcement).

I'm not just talking here about "imagination" in the sense of fairy tales: we use imaginative cognition to make sense of any situation described to us from afar. When presented with linguistic reports of not-directly-observable situations, we need to build cognitive frames modeling the context as it is discussed. In the terms I suggested earlier, we build a "doxa inventory" tracking beliefs and assertions. Sometimes this means internalizing relatively transparent logical forms. But sometimes it means building a narrative/visual account, playing an imaginary version of the situation in our minds. Language could not signify in its depth and nuance without triggering this *interpretive-imaginative* faculty. Cognitively, then, language is an *intermediary* to this cognitive system. Using terms from Olin Vakarelov's "Interface Theory of Meaning" [33], [34] we might say that language is an *interface to* interpretive-imaginative cognitive capabilities.

3.4 Cognitive-Transform Interpretation

My argument is then that extra-linguistic cognition — e.g., narrative construals, or situational understanding — can supply crucial steps in the emergence of sentences’ intended propositional content; so relying on logical assessment of propositional content and correlated linguistic patterns is, at best, incomplete. I have presented numerous sentences which, in my opinion, evince patterns whose rational contributions lie outside linguistic cognition proper, but which become attached as interpretations or refinements of given linguistic content; for example the semantic model of *critical mass* or *tipping point* encapsulating a complex situational presenting.

The extra-linguistic source of many signifying contributors can be observed directly in reference to more formalized (say, Dependency-Grammatic) analyses (or indeed what they leave out). In the (34) case, the modifier *actually* implies that the asserted fact is somehow surprising and counterintuitive; it’s easy enough to conclude that the speaker senses a certain lexical frisson, particularly in how *camping* is described as *lodging*. So the work of (34) is not just to point out that people camp on the beach, but also that this arrangement is the most popular “lodging” even though in its usual sense *lodging* applies more to hotels and inns. This latter pattern circuits especially through the words *actually*, *lodging*, and *camping*, none of which are word-relations identified by the Universal Dependency parse (refer back to Figure ??) but which can be seen as a second-order network superimposed on the sentence’s syntactic core.

For other examples, in (??) the *colonial ambience* and *tropical climate* disjunction partly shifts the sense of *the city* from its status as something constructed and historical (the *architecture* is colonial) to a geographic location. We of course read *the climate* as *its* (the city’s) climate, which establish a link between the two *the*. This is almost anaphoric — if the phrase were *its climate* we would resolve *it* backward to *the city* — but the pattern is varied, by replacing *its climate* with *the climate*, which conceptually foregrounds the aspect of climate as an ambient phenomenon (amenable to a definite article) rather than just a possession (viz., a property of geographic places). So there are several intersecting patterns — both referential commonality and interpretive changes (see also the “Liverpool” examples for city qua architecture and qua locale) — between the two sentence-halves, which are not described in the parse-graph. And in, say,

- ▼ (97) We understand that the pipe fitters are also planning to picket the Lake Worth, Florida project as well. (en_gum-ud-train)

there is a two-layer scope implication: given *also* we read the hearer as knowing that they are picketing some *other* project. But we also hear *the pipe fitters* as referring to some

specific group of pipefitters, with which the speaker has some contractual relation; we do not interpret this as a comment about pipe-fitters in general.

The details of (97), in short, bound the scope of *the pipe fitters* from both above and below. The importance of *also* for this interpretive understanding is elided from the copora parse-graph, which just sees *also* as a common auxiliary. In general, the extra “layers” of meaning I have identified for (??), (??), and (97) require some interpretive (and seemingly extralinguistic) reasoning, so they are not explicitly traced in purely formulaic Intermediate Representations involving core linguistic aspects, such as parse-graphs vis-à-vis syntax.

The extralinguistic dimensions of language are not, of course, completely apart from language: extralinguistic reasoning is appropriate to fill in the gaps left by straightforward syntactic or logico-semantic intellection alone, but those gaps exist *because* language leads (via intra-linguistic structures) to signifying complexes. The logic and conceptual detail achieved through intra-linguistic processes set forth the parameters on extra-linguistic cognition that supplements them; so analytic coverage of the intra-linguistic aspect is still requisite for good analysis of the extra-linguistic. This formal necessity, however, should not be mistaken for a belief that logically-inflected models of syntax and semantics are complete or self-sufficient. Full implementation of a rigorous, logical syntactic-semantic system still does not get us to *language*.

4 Pragmatics and Logical Incompleteness

Another motivation for something like an Interface Theory of Meaning comes from cases where language users seem to traffic in a relative *absence* of semantic determinism, with no detrimental effects to the *telos* of language in context. This buttresses an idea that language is not targeted at doxic specificity as a precondition for meaning in general, but rather packages doxa along with other contextualizing constituents in the service of pragmatic ends. Consider:

- ▼ (98) My colleague Ms. O’Shea would like to interview Mr. Jones, who’s an old friend of mine. Can he take this call?
- ▼ (99) I’m sorry, this is his secretary. Mr. Jones is not available at the moment.

It sounds like Ms. O’Shea is trying to use personal connections to score an interview with Mr. Jones. Hence her colleague initiates a process intended to culminate in Ms. O’Shea getting on the telephone with Mr. Jones. But his secretary demurs with a familiar phrase, deliberately formulated to foment ambiguity: (99) could mean that Mr. Jones is not in the office, or that he is in a meeting, or he is unwilling to

talk, or even missing (like the ex-governor consummating an affair in Argentina while his aides thought he was hiking in Virginia). Or:

- ▼ (100) Mr. Jones, were you present at a meeting where the governor promised your employer a contract in exchange for campaign contributions?
- ▼ (101) After consulting with my lawyers, I decline to answer that question on the grounds that it may incriminate me.

Here Mr. Jones neither confirms nor denies his presence at a corrupt meeting.

As these examples intimate, the processes language initiates do not always result in a meaningful logical structure. But this is not necessarily a complete breakdown of language:

- ▼ (102) Is Jones there?
- ▼ (103) He is not available.

The speaker of (103) does not provide any *prima facie* logical content: it neither affirms nor denies Jones's presence. Nonetheless that speaker is a cooperative conversational partner (even if they are not being very cooperative in real life): (103) responds to the implicature in (102) that what the first speaker really wants is to interview Jones. So the second speaker conducts what I called a "transform" and maps *Jones is here* to *Jones is willing to be interviewed*. Responding to this "transformed" question allows (103) to be (at least) linguistically cooperative while nonetheless avoiding a response at the *logical* level to (102). (103) obeys conversational maxims but is still rather obtuse.

So one problem for theories that read meanings in terms of logically structured content — something like, the meaning of an (assertorial) sentence is what the world would be like if the sentence were true — is that the actual logical content supplied by some constructions (like *Jones is not available*) can be pretty minimal — but these are still valid and conversationally cooperative segments of discourse. To be sure, this content does not appear to be *completely* empty: "Jones is not available" means the conjunction of several possibilities (he cannot be found or does not want to talk or etc.). So (103) does seem to evoke some disjunctive predicate. But such does not mean that this disjunctive predicate is the *meaning* of (103). It does not seem as if (103) when uttered by a bodyguard is intended first and foremost to convey the disjunctive predicate. Instead, the bodyguard is responding to the implicature in the original *Is Jones there?* query — the speaker presumably does not merely want to know Jones's location, but to see Jones. Here people are acting out social roles, and just happen to be using linguistic expressions to negotiate what they are able and allowed to do.

Performing social roles — including through language — often involves incomplete information: possibly the secretary

or bodyguard themselves do not know where Jones is or why he's not available. We could argue that there is *enough* information to still ground *some* propositional content. But this is merely saying that we can extract some propositional content from what speakers are supposed to say as social acts, which seems to make the content (in these kinds of cases) logically derivative on the enactive/performative meaning of the speech-acts, whereas a truth-theoretic paradigm would need the derivational dependence to run the other way. By saying *Jones is unavailable* the speaker is informing us that our own prior speech act (asking to see or talk to him) cannot have our desired effect — the process we initiated cannot be completed, and we are being informed of that. The person saying *Jones is unavailable* is likewise initiating a *new* process, one that counters our process and, if we are polite and cooperative, will have its own effect — the effect being that we do not insist on seeing Jones. The goal of "Jones is unavailable" is to create that effect, nudging our behavior in that direction. Any *logic* here seems derivative on the practical initiatives.

And moreover this practicality is explicitly marked by how the chosen verbiage is deliberately vague. The declaration "Jones is unavailable" does not *need* logical precision to achieve its effect. It needs *some* logical content, but it exploits a kind of disconnect between logical and practical/enactive structure, a disconnect which allows "Jones is unavailable" to be at once logically ambiguous and practically clear — in the implication that we should not try to see Jones. I think this example has some structural analogs to the grandma's window case: *there* we play at logical substitutions to respond practically to grandma's request in spirit rather than *de dicto*. *Here* a secretary or bodyguard can engage in logical substitution to formulate a linguistic performance designed to be conversationally decisive while conveying as little information as possible. The logical substitution in grandma's context *added* logical content by trying alternatives for the window being closed; here, the context allows a *diminution* in logical content. We can strip away logical detail from our speech without diminishing the potency of that speech to achieve affects. And while the remaining residue of logical content suggests that some basic logicity is still essential to meaning, the fact that logical content can be freely subtracted without altering practical effects suggests that logic's relation to meaning is something other than fully determinate: effect is partially autonomous from logic, so a theory of effect would seem to be partially autonomous from a theory of logic. I can be logically vague without being conversationally vague. This evidently means that conversational clarity is not identical to logical clarity.

4.1 Interpretive Processes and Triggers

We can, indeed, find certain analogs between formal logic and Natural Language — for example, singular/plural *can* be a basically straightforward translation of the individual/set distinction in symbolis logic. Such formal intuitions are limited in the sense that (to continue this example) the conceptual mapping from single to plural can reflect a wide range of residual details beyond just quantity and multitudes. Compare *I sampled some chocolates* (where the count-plural suggests *pieces* of chocolate) and *I sampled some coffees* (where the count-plural implies distinguishing coffees by virtue of grind, roast, and other differences in preparation) (note that both are contrasted to mass-plural forms like *I sampled some coffee* where plural agreement points toward material continuity; there is no discrete unit of coffee qua liquid). Or compare *People love rescued dogs* with *People fed the rescued dogs* — the second, but not the first, points toward an interpretation that certain *specific* people fed the dogs (and they did so *before* the dogs were rescued).

The assumption that logical modeling can capture all the pertinent facets of Natural-Language meaning can lead us to miss the amount of situational reasoning requisite for commonplace understanding. In *People fed the rescued dogs* there is an exception to the usual pattern of how tense and adjectival modification interact: we read “people fed” in *People fed the rescued dogs* as occurring *before* the rescue; because we assume that *after* being rescued the dogs would be fed by veterinarians and other professionals (who would probably not be designated with the generic “people”), and also we assume the feeding helped the dogs survive. We also hear the verb as describing a recurring event; compare with *I fed the dog a cheeseburger*.

To be sure, there are patterns and templates governing scope/quantity/tense interactions that help us build logical models of situations described in language. Thus *I fed the dogs a cheeseburger* can be read such that there are multiple cheeseburgers — each dog gets one — notwithstanding the singular form on *a cheeseburger*: the plural *dogs* creates a scope that can elevate the singular *cheeseburger* to an implied plural; the discourse creates multiple reference frames each with one cheeseburger. Likewise the morphosyntax is quite correct in: *All the rescued dogs are taken to an experienced vet; in fact, they all came from the same veterinary college* — the singular on *vet* is properly aligned with the plural *they* because of the scope-binding (from a syntactic perspective) and space-building (from a semantic perspective) effects of the “dogs” plural. Or, in the case of *I fed the dog a cheeseburger every day* there is an implicit plural because “every day” builds multiple spaces: we can refer via the spaces collectively using a plural (*I fed the dog a cheeseburger every day* — *I made them at home with vegan cheese*) or refer within one space more narrowly, switching to the singular (*Except Tuesday,*

when it was a turkey burger).

Layers of scope, tense, and adjectives interact in complex ways that leave room for common ambiguities: *All the rescued dogs are [/were] taken to an experienced [/specialist] vet* is consistent with a reading wherein there is exactly one vet, and she has or had treated every dog. It is *also* consistent with a reading where there are multiple vets and each dog is or was treated by one or another. Resolving such ambiguities tends to call for situational reasoning and a “feel” for situations, rather than brute-force logic. If a large dog shelter describes their operational procedures over many years, we might assume there are multiple vets they work or worked with. If instead the conversation centers on one specific rescue we would be inclined to imagine just one veterinarian. Lexical and tense variation also guides these impressions: the past-tense form (*...the rescued dogs were taken...*) nudges us toward assuming the discourse references one rescue (though it could also be a past-tense retrospective of general operations). Qualifying the vet as *specialist* rather than the vaguer *experienced* also nudges us toward a singular interpretation.

What I am calling a “nudge”, however, is based on situational models and arguably flows from a conceptual stratum outside of both semantics and grammar proper; maybe it is even prelinguistic. Consider

- ▼ (104) People fed the rescued dogs.
- ▼ (105) Vets examined the rescued dogs.

There appears to be no explicit principle either in the semantics of the lexeme *to feed*, or in the relevant tense agreements, stipulating that the feeding in (104) was prior to the rescue — or conversely that (105) describes events *after* the rescue. Instead, we interpret the discourse through a narrative framework that fills in details not provided by the language artifacts explicitly (that abandoned dogs are likely to be hungry; that veterinarians treat dogs in clinics, which dogs have to be physically brought to). For a similar case-study, consider the sentences:

- ▼ (106) Every singer performed two songs.
- ▼ (107) Everyone performed two songs.
- ▼ (108) Everyone sang along to two songs.
- ▼ (109) Everyone in the audience sang along to two songs.

The last of these examples strongly suggests that of potentially many songs in a concert, exactly two of them were popular and singable for the audience. The first sentence, contrariwise, fairly strongly implies that there were multiple pairs of songs, each pair performed by a different singer. The middle two sentences imply either the first or last reading, respectively (depending on how we interpret “everyone”). Technically, the first two sentences imply a multi-space reading and the latter two a single-space reading. But the driving force behind these implications are the pragmatics of *perform* versus *sing along*:

the latter verb is bound more tightly to its subject, so we hear it less likely that *many* singers are performing *one* song pair, or conversely that every audience member *sings along* to one song pair, but each chooses a *different* song pair.

The competing interpretations for *perform* compared to *sing along*, and *feed* compared to *treat*, are grounded in lexical differences between the verbs, but I contend the contrasts are not laid out in lexical specifications for any of the words, at least so that the implied readings follow just mechanically, or on logical considerations alone. After all, in more exotic but not implausible scenarios the readings would be reversed:

- ▼ (110) The rescued dogs had been treated by vets in the past (but were subsequently abandoned by their owners).
- ▼ (111) Every singer performed (the last) two songs (for the grand finale).
- ▼ (112) Everyone in the audience sang along to two songs (they were randomly handed lyrics to different songs when they came in, and we asked them to join in when the song being performed onstage matched the lyrics they had in hand).

In short, it's not as if dictionary entries would specify that *to feed* applies to rescued dogs before they are rescued, and so forth; these interpretations are driven by narrative construals narrowly specific to given expressions. The appraisals would be very different for other uses of the verbs in (lexically) similar (but situationally different) cases: to "treat" a wound or a sickness, to "perform" a gesture or a play. We construct an interpretive scaffolding for resolving issues like scope-binding and space-building based on fine-tuned narrative construals that can vary a lot even across small word-sense variance: As we follow along with these sentences, we have to build a narrative and situational picture which matches the speaker's intent, sufficiently well.

And that requires prelinguistic background knowledge which is leveraged and activated (but not mechanically or logically constructed) by lexical, semantic, or grammatical rules and forms: *rescued dogs* all alone constructs a fairly detailed mental picture where we can fill in many details by default, unless something in the discourse tells otherwise (we can assume such dogs are in need of food, medical care, shelter, etc., or they would not be described as "rescued"). Likewise *sing along* carries a rich mental picture of a performer and an audience and how they interact, one which we understand based on having attended concerts rather than by any rule governing *along* as a modifier to "sing" — compare the effects of *along* in *walk along*, *ride along*, *play along*, *go along*. Merely by understanding how *along* modifies *walk*, say (which is basically straightforward; to "walk along" is basically to "walk alongside") we would not automatically generalize to more idiomatic and metaphorical uses like "sing along" or "play along" (as in *I was skeptical but I played along (so as not to start an argument)*).

We have access to a robust collection of "mental scripts" which represent hypothetical scenarios and social milieus where language plays out. Language can activate various such "scripts" (and semantic as well as grammatical formations try to ensure that the "right" scripts are selected). Nonetheless, we can argue that the conceptual and cognitive substance of the scripts comes not from language per se but from our overall social and cultural lives. We are disposed to make linguistic inferences — like the timeframes implied by *fed the rescued dogs* or the scopes implied by *sang along to two songs* — because of our enculturated familiarity with events like dog rescues (and dog rescue organizations) and concerts (plus places like concert halls). These concepts are not produced by the English language, or even by any dialect thereof (a fluent English speaker from a different cultural background would not necessarily make the same inferences — and even if we restrict attention to, say, American speakers, the commonality of disposition reflects a commonality of the relevant cultural anchors — like dog rescues, and concerts — rather than any homogenizing effects of an "American" dialect). For these reasons, I believe that trying to account for situational particulars via formal language models alone is a dead end. This does not mean that formal language models are unimportant, only that we need to picture them resting on a fairly detailed prelinguistic world-disclosure.

There are interesting parallels in this thesis to the role of phenomenological analysis, and the direct thematization of issues like attention and intentionality: analyses which are truly "to the things themselves" should take for granted the extensive subconscious reasoning that undergirds what we consciously thematize and would be aware of, in terms of what we deliberately focus on and are conscious of believing (or not knowing), for a first-personal exposé. Phenomenological analysis should not consider itself as thematizing every small quale, every little patch of color or haptic/kinesthetic sensation which by some subconscious process feeds into the logical picture of our surroundings that props up our conscious perception. Analogously, linguistic analysis should not thematize every conceptual and inferential judgment that guides us when forming the mental, situational pictures we then consult to set the groundwork for linguistic understanding proper.

These comments apply to both conceptual "background knowledge" and to situational particulars of which we are cognizant in reference to our immediate surroundings and actions. This is the perceptual and operational surrounding that gets linguistically embodied in deictic reference and other contextual "groundings". Our situational awareness therefore has both a conceptual aspect — while attending a concert, or dining at a restaurant, say, we exercise cultural background knowledge to interpret and participate in social events — and also our phenomenological construal of our locales, our immediate spatial and physical surroundings. Phenomenological philosophers have explored in detail how these two facets of sit-

uationality interconnect (David Woodruff Smith and Ronald McIntyre in *Husserl and Intentionality: A Study of Mind, Meaning, and Language*, for instance). Cognitive Linguistics covers similar territory; the “cognitive” in Cognitive Semantics and Cognitive Grammar generally tends to thematize the conception/perception interface and how both aspects are merged in situational understanding and situationally grounded linguistic activity (certainly more than anything involving Artificial Intelligence or Computational Models of Mind as are connoted by terms like “Cognitive Computing”). Phenomenological and Cognitive Linguistic analyses of situationality and perceptual/conceptual cognition (cognition as the mental synthesis of preception and conceptualization) can certainly enhance and reinforce each other.

But in addition, both point to a cognitive and situational substratum underpinning both first-person awareness and linguistic formalization proper — in other words, they point to the thematic limits of phenomenology and Cognitive Grammar and the analytic boundary where they give way to an overarching Cognitive Science. In the case of phenomenology, there are cognitive structures that suffuse consciousness without being directly objects of attention or intention(ality), just as sensate hyletic experience is part of our consciousness but not, as explicit content, something we in the general case are conscious *of*. Analogously, conceptual and situational models permeate our interpretations of linguistic forms, but are not presented explicitly *through* these forms: instead, they are solicited obliquely and particularly.

What phenomenology *should* explicate is not background situational cognition but how attention, sensate awareness, and intentionality structure our orientation *vis-à-vis* this background: how variations in focus and affective intensity play strategic roles in our engaged interactions with the world around us. Awareness is a scale, and the more conscious we are of a sense-quality, an attentional focus, or an epistemic attitude, reflects our estimation of the importance of that explicit content compared to a muted experiential background. Hence when we describe consciousness as a stream of *intentional* relations we mean not that the intended noemata (whether perceived objects or abstract thoughts) are sole objects of consciousness (even in the moment) but are that within conscious totality which we are most aware of, and our choice to direct attention here and there reflects our intelligent, proactive interacting with the life-world. Situational cognition forms the background, and phenomenology addresses the structure of intentional and attentional modulations constituting the conscious foreground.

Analogously, the proper role for linguistic analysis is to represent how multiple layers or strands of prelinguistic understanding, or “scripts”, or “mental spaces”, are woven together by the compositional structures of language. For instance, *The rescued dogs were treated by an experienced vet* inte-

grates two significantly different narrative frames (and space-constructions, and so forth): the frame implied by “rescued dogs” is distinct from that implied by “treated by a veterinarian”. Note that both spaces are available for follow-up conversation:

- ▼ (113) The rescued dogs were treated by an experienced vet. One needed surgery and one got a blood transfusion. We went there yesterday and both looked much better.
- ▼ (114) The rescued dogs were treated by an experienced vet. One had been struck by a car and needed surgery on his leg. We went there yesterday and saw debris from another car crash — it’s a dangerous stretch of highway.

In the first sentence *there* designates the veterinary clinic, while in the second it designates the rescue site. Both of these locales are involved in the original sentence (as locations and also “spaces” with their own environments and configurations: consider these final three examples).

- ▼ (115) The rescued dogs were treated by an experienced vet. We saw a lot of other dogs getting medical attention.
- ▼ (116) The rescued dogs were treated by an experienced vet. It looked very modern, like a human hospital.
- ▼ (117) The rescued dogs were treated by an experienced vet. We looked around and realized how dangerous that road is — for humans as well as dogs.

What these double space-constructions reveal is that accurate language understanding does not only require the proper activated “scripts” accompanying words and phrases, like “rescued dogs” and “treated by a vet”. It also requires the correct integration of each script, or each mental space, tying them together in accord with speaker intent. So in the current example we should read that the dogs *could* be taken to the vet *because* they were rescued, and *needed* to be taken to the vet *because* they needed to be rescued. Language structures guide us toward how we should tie the mental spaces, and the language segments where they are constructed, together: the phrase “*rescued dogs*” becomes the subject of the passive-voice *were treated by a vet* causing the two narrative strands of the sentence to encounter one another, creating a hybrid space (or perhaps more accurately a patterning between two spaces with a particular temporal and causal sequencing; a hybrid narration bridging the spaces). It is of course this hybrid space, this narrative recount, which the speaker intends via the sentence. This idea is what the sentence is crafted to convey — not just that the dogs were rescued, or that they were taken to a vet, but that a causal and narrative thread links the two events.

I maintain, therefore, that the analyses which are proper to linguistics — highlighting what linguistic reasoning contributes above and beyond background knowledge and situational cognition — should focus on the *integration* of multiple mental

“scripts”, each triggered by different parts and properties of the linguistic artifact. The *triggers* themselves can be individual words, but also morphological details (like plurals or tense marking) and morphological agreement. On this theory, analysis has two distinct areas of concerns: identification of grammatical, lexical, and morphosyntactic features which trigger (assumedly prelinguistic) interpretive scripts, and reconstructing how these scripts interoperate (and how language structure determines such integration).

In the case of isolating triggers, a wide range of linguistic features can trigger interpretive reasoning — including base lexical choice; word-senses carry prototypical narrative and situational templates that guide interpretation of how the word is used in any given context. *Rescued*, for example, brings on board a network of likely externalities: that there are rescuers, typically understood to be benevolent and intending to protect the rescuees from harm; that the rescuees are in danger prior to the rescue but safe afterward; that they need the rescuers and could not have reached safety themselves. Anyone using the word “rescue” anticipates that their addressees will reason through some such interpretive frame, so the speaker’s role is to fill in the details descriptively or deictically: who are the rescuees and why they are in danger; who are the rescuers and why they are benevolent and able to protect the rescuees. The claim that the word *rescue*, by virtue of its lexical properties, triggers an interpretive “script”, is a proposal to the effect that when trying to faithfully reconstruct speaker intentions we will try to match the interpretive frame to the current situation.

The “script” triggered by word-choice is not just an interpretive frame in the abstract, but the interpretive *process* that matches the frame to the situation. This process can be exploited for metaphorical and figurative effect, broadening the semantic scope of the underlying lexeme. In the case of “rescue” we have less literal and more humorous or idiomatic examples like:

- ▼ (118) The trade rescued a star athlete from a losing team.
- ▼ (119) New mathematical models rescued her original research from obscurity.
- ▼ (120) Discovery of nearby earth-like planets rescued that star from its reputation as ordinary and boring and revealed that its solar system may actually be extraordinary.

Each of these cases subverts the conventional “rescue” script by varying some of the prototypical frame details: maybe the “danger” faced by the rescuee is actually trivial (as in the first three), or the rescuee is not a living thing whose state we’d normally qualify in terms of “danger” or “safety”, or by overturning the benevolence we typically attribute to rescue events. But in these uses subverting the familiar script does not weaken the lexical merit of the word choice; instead, the interpretive act of matching the conventional “rescue” script

to the matter at hand reveals details and opinions that the speaker wishes to convey. The first sentence, for instance, uses “rescue” to connote that being stuck on a losing team is an unpleasant (even if not life-threatening) circumstance. So one part of the frame (that the rescuee needs outside intervention) holds while the other (that the rescue is in danger) comes across as excessive but (by this very hyperbole) communicating speaker sentiment. By both invoking the “rescue” script and exploiting mismatches between its template case and the current context, the speaker conveys both situational facts and personal opinions quite economically. Similarly, *rescue a paper from obscurity* is an economical way of saying that research work has been rediscovered in light of new science; and “rescued from a reputation” is a clever way of describing, with rhetorical force, how opinion of changed about someone or something.

All of these interpretive effects — both conventional and unconventional usages — stem from the interpretive scripts bound to words (and triggered by word-choice) at the underlying lexical level — we can assess these by reference to lexical details alone, setting aside syntactic and morphological qualities. When morphosyntactic details *are* considered — e.g. plurals, as in (??)-(??) — we then have a spectrum of other linguistic “triggers”, involving perceptual and enactive figurations (e.g. how plurality/multiplicities are conceived), alongside interpretive “scripts”. My essential point however is that language needs to *trigger* certain interpretive, perceptual, and enactive/operational processes.

I contend, moreover, that these cognitive processes are not *themselves* linguistic: while they may overlap with some language-relevant concerns (like conceptualization, and doxic specificity) they are not woven from the cloth of syntactic, semantic, or pragmatic elements internal to language. It is not within the purview of linguistics then to analyze interpretive scripts (except as a subsidiary case-study), or perceptual understanding, or situationally-mediated action. What *can* be left for linguistics proper is identifying the *triggers* to these cognitive realities — insofar as content or formations in language, within our goal-directed attempt to understand others’ linguistic performances, compels us toward these extralinguistic registers.

Linguistics on this perspective is necessarily and properly incomplete: we should not look to linguistic analysis to materially or structurally explain the cognitive processes triggered by language. But we *can* analyze the triggers themselves — potentially via formal and even computational methods. So the formal models I reviewed earlier — such as the combination of Dependency graphs with typed S-Expressions encoded via double-indices — can be adopted in a basically non-formalized, cognitive-linguistic paradigm, insofar as we ascribe to the global picture of language as an “interface” or “trigger” to extralinguistic cognition.

4.2 *Gaps in Logical Phrase-Models*

Assume we have a baseline lambda-calculus-like functional summary of sentences and derived types. That is, any sentence can be rewritten as if a sequence of “function calls”, assuming an underlying representational vocabulary of a typed lambda calculus, with sentences having overall *Prop* types. S-Expression reconstruction presents one layer of structure — for example, the connection of verbs to their one, two, or three arguments — which can then be overlaid with Link-Grammar style pairs, like verb-to-subject and verb-to-direct-object. ‘p’

My overall goal is to embrace a hybrid methodology — accepting formal analyses when they shed light on linguistic processes, but not going so far as to treat logical, mathematical, or computational models as full explanations for linguistic rationality qua scientific phenomenon. The path toward such a hybrid methodology, as I will sketch it here, takes its inspiration and orientation from Cognitive Grammar. This perspective, in particular, challenges our assumption that grammar and semantics are methodologically separate. Received wisdom suggests that grammar concerns the “form” of sentences whereas semantics considers the meaning of words — implicitly assuming that *word combinations* produce new meanings, and that the *order* by which words are combined determines how new meanings are produced. This notion, in turn, is allied with the essentially logical or propositional picture of signifying via doxa: the idea that inter-word relations cue up different logically salient transformations of an underlying predicate model. Thus *many students* as a phrase is more significatorily precise than *students* as a word, because the phrase (with intimations of quantitative comparison) has more logical detail. Similarly *many students complained* is more logically complete because, provisioning both a verb-idea and a noun-idea, it represents a whole proposition.

In general, then, phrases are more complete than words because they pack together more elements which have some logical role, establishing individuals, sets, spatiotemporal setting, and predicates which collectively establish sufficiently completed propositional attitudes. On this account the key role of phrase-structure is to establish phrases as signifying units on a logical level analogous to how lexemes are signifying units on a referential or conceptual level. Moreover, phrases’ internal structure are understood to be governed by rule defining *how* word-combinations draw in extra logical detail. A link between words is not a random synthesis of concepts, but rather implies a certain logical connective which acts as a de facto “third party” in a double-word link, proscribing with orientation to predicate structures *how* the words’ semantic concepts are to be joined. In *many students* the implied connector is the propositional act of conceiving a certain quantitative scale to a conceptualized set; in *students complained* the implied connector is a subject-plus-verb-equals-proposition assertiveness. Phrases acquire logical specificity

by building up word-to-word connections into more complex aggregates.

One implication of this model is that phrases are semantically substitutable with individual lexemes that carry similar meanings, having been entrenched by convention to capture a multipart concept which would otherwise be conveyed with the aggregation of a phrase: consider “MP” for *member of parliament*, or “primaried” for *subject without your own party to a primary challenge*. Conversely, phrases can be repeatedly used in a specific context until they function as quasi lexical units in their own right. These patterns of entrenchment imply that we hear language in term of phrases bearing semantic content; and insofar as we are comfortable with how we parse a sentence, each word sited in its specific phrasal hierarchy, we do not tend to consider individual words semantically outside of their constituent phrases.

This theory of the syntax-to-semantic relationship is a paradigmatic partner, at the grammatic level, to truth-theoretic semantics and as such, I maintain, is subject to similar critiques as I developed semantically in the last two sections. A critique of grammatic theories based on, let’s say, “*propositional semantics of phrase-structure*” can address two concerns: first, the idea that lexemes retain some syntactic and semantic autonomy even within clearly defined phrases where they are included; and, second, that the shape of phrases insofar as they are perceived as holistic signifying units is often driven by figurative or “gestalt” principles rather than neat logical structuration. I’ll call the former the issue of “phrasal isolation” (or lack thereof): syntactic and semantic effect often cross phrasal boundaries, even outside the overarching hierarchy whose apex is the whole sentence. Both of these lines of reasoning — arguably especially the second — are developed in Cognitive Grammar literature.

In Ronald Langacker’s *Foundations of Cognitive Grammar*, the sentence

- ▼ (121) Three times, students asked an interesting question.

is used to demonstrate how grammatical principles follow from cognitive “construals” of the relevant situations, those which language seeks to describe or takes as presupposed context.⁷ In particular, Langacker argues that “students” and “question” can both be either singular or plural: syntax is open-ended here, with neither form more evidently correct. Langacker uses this example to make the Cognitive-Linguistic point that we assess syntactic propriety relative to cognitive frames and conversational context. In this specific case, we are actually working with two different cognitive frames which are interlinked — on the one hand, we recognize distinct events consisting of a student asking a question, but the speaker calls attention, too, to their recurrence, so the events can

⁷For example, [20, pp. 119 and 128], discussed by [7, p. 189], and [24, p. 9].

also be understood as part of a single, larger pattern. There are therefore two different cognitive foci, at two different scales of time and attention, a “split focus” which makes both singular and plural invocations of “student” and “question” acceptable.

Supplementing this analysis, however, we can additionally focus attention directly on grammatical relations. The words *student* and *question* are clearly linked as the subject and object of the verb *asked*; yet, contrary to any simple presentation of rules, no agreement of singular or plural is required between them (they can be singular and/or plural in any combination). Moreover, this anomaly is only in force due to the context established by an initial phrase like *three times*; absent some such framing, the singular/plural relation would be more rigid. For example, “A student asked interesting questions” would (in isolation) strongly imply *one* student asking *several* questions. So the initial “Three times” phrase alters how the subsequent phrase-structure is understood while remaining structurally isolated from the rest of the sentence. Semantically, it suggests a “space builder” in the manner of Gilles Fauconnier or Per Aage Brandt [?]; [9], but we need to supplement Mental Space analysis with a theory of how these spaces influence syntactic acceptability, which would seem to be logically prior to the stage where Mental Spaces would come in play.

The mapping of (121) to a logical substratum would be more transparent with a case like:

- ▼ (122) Three students asked interesting questions.

(122) is a more direct translation of the facts which the original sentence conveys. But this “more logical” example has different connotations than the sentence Langacker cites; (121) places the emphasis elsewhere, calling attention more to the idea of something temporally drawn-out, of a recurrence of events and a sense of time-scale. The “more logical” sentence lacks this direct invocation of time scale and temporal progression.

We can say that the “Three students” version is a more direct statement of fact, whereas Langacker’s version is more speaker-relative, in the sense that it elaborates more on the speaker’s own acknowledgment of belief. The speaker retraces the steps of her coming to appreciate the fact — of coming to realize that the “interesting questions” were a recurrent phenomenon and therefore worthy of mention. By situating expressions relative to cognitive processes rather than to the facts themselves, the sentence takes on a structure which models the cognition rather than the states of affairs. But this shift of semantic grounding from the factual to the cognitive also apparently breaks down the logical orderliness of the phrase structure. “Three times”, compared to “three students”, leads to a morphosyntactic choice-space which is “underdetermined” and leaves room for speakers’ shades of emphasis.

This is not an isolated example. Many sentences can be provided with similar phrase-structure complications, particularly with respect to singular/plural agreement.

- ▼ (123) Time after time, tourists (a tourist) walk(s) by this building with no idea of its history.
- ▼ (124) The streets around here are confusing; often people (someone) will ask me for directions.
- ▼ (125) Student after student came with their (his/her) paper to complain about my grade(s).
- ▼ (126) Student after student — and their (his/her) parents — complained about the tuition increase.

On a straightforward phrase-structure reading, *student after student* reduces to an elegant equivalent of *many students*, with the rhetorical flourish abstracted away to a logical form. But our willingness to accept both singular and plural agreements (his/her/their parents, grades, papers) shows that clearly we don’t simply substitute *many students*; we recognize the plural as a logical gloss on the situation but engage the sentence in a more cognitively complex way, recognizing connotations of temporal unfolding and juxtapositions of cognitive frames. The singular/plural underdeterminism is actually a signification in its own right, a signal to the listener that the sentence in question demands a layered cognitive attitude. Here again, syntactic structure (morphosyntactic, in that syntactic allowances are linked with variations in the morphology of individual words, such as singular or plural form) serves to corroborate conversants’ cognitive frames rather than to model logical form.

The contrast between the phrases *Student after student* and *Many students* cannot be based on “abstract” semantics alone — how the evident temporal implications of the first form, for example, are concretely understood, depends on conversants’ mutual recognition of a relevant time frame. The dialog may concern a single day, a school year, many years. We assume that the speakers share a similar choice of time “scale” (or can converge on one through subsequent conversation). *Some* time-frame is therefore presupposed in the discursive context, and the first phrase invokes this presumed but unstated framing. The semantics of the phrase are therefore somewhat open-ended: the phrase “hooks into” shared understanding of a temporal cognitive framing without referring to it directly. By contrast, the second phrase is less open-ended: it is consistent with both a more and less temporally protracted understanding of *many*, but leaves such details (whatever they may be) unsignified. The factual circumstance is designated with a level of abstraction that sets temporal considerations outside the focus of concern. The second (“*Many students*”) phrase is therefore both less open-ended and also less expressive: it carries less detail but accordingly also relies less on speaker’s contextual understanding to fill in detail.⁸

⁸The examples I have used so far may also imply that a choice of phrase

One consequence of these analyses is that grammar needs to be approached holistically: the grammatic structure of phrases cannot, except when deliberate oversimplification is warranted, be isolated from surrounded sentences and still larger discourse units. Semantic roles of phrases have some effect on their syntax, but phrases are nonetheless chosen from sets of options, whose variations reflect subtle semantic and syntactic maneuvers manifest at super-phrasal scales. The constituent words of phrases retain some autonomy, and can enter into inter-word and phrasal structures with other words outside their immediate phrase-context. We can still apply formal models to phrase structure — for example, as I mentioned, Applicative and Cognitive Grammar considers phrases as “applications” of (something like) linguistic or cognitive functions, with (say) an adjective modeled as a function applied to a noun, to yield a different noun (viz., something playing a noun’s conceptual role) [?]. But we should not read these transformations — like *rescued dogs* from *dogs* — too hastily as a purely semantic correlation within a space of denotable concepts — *such that* the new concept wholly replaces the contained parts, which then cease to have further linguistic role and effect. Instead, applicative structures represent shifts or evolutions in mental construal, which proceed in stages as conversants form cognitive models of each others’ discourse. Even if phrase structure sets landmarks in this unfolding, phrases do not wholly subsume their constituents; the parts within phrases do not “vanish” on the higher scale, but remain latent and may be “hooked” by other, overlapping phrases.

Consider the effect of “Many students complained”. Propositionally, this appears to say essentially that *students* complained; but, on hermeneutic charity, the speaker had *some* reason to say “many”. The familiar analysis is that “many” suggests relative size; but this is only half the story. If the speaker chose merely *students complained*, we would hear an assertion that more than one student did, but we would also understand that there were several occasions when complaints happened. Adding “many” does not just imply “more” stu-

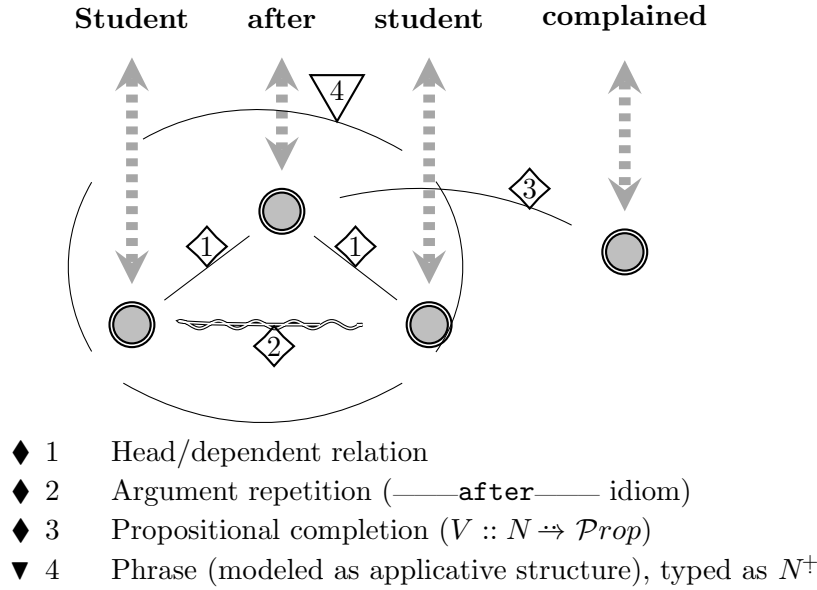
structure is always driven by semantic connotations of one structure or another; but seemingly the reverse can happen as well — speakers choose a semantic variant because its grammatic realization lends a useful organization to the larger expression. There are many ways to say “many”, for example: *a lot of*, *quite a few*, not to mention “time after time” style constructions. Whatever their subtle semantic variations, these phrases also have different syntactic properties: *Quite a few* is legitimate as standalone (like an answer to a question); *A lot of* is not, and *A lot* on its own is awkward. On the other hand the “of” in *A lot of* can “float” to be replicated further on: “A lot of students, of citizens, believe education must be our top priority” sounds more decorous than the equivalent sentence with the second “of” replaced by “and”. If the cadence of that sentence appeals to the speaker, then such stylistic preference will influence taking “A lot of” as the “many” variant of choice. So speakers have leeway in choosing grammatic forms that highlight one or another aspect of situations; but they also have leeway in choosing rhetorical and stylistic pitch. Both cognitive framings and stylistic performance can be factored when reconstructing what compels the choice of one sentence over alternatives.

dents, but suggests a mental shift away from the particular episodes. In the other direction, saying *a student complained* is not just asserting how at least one student did so, but apparently reports one specific occasion (which perhaps the speaker wishes to elaborate on). In other words, we cannot really capture the singular/plural semantics, or different varieties of plural, just by looking at the relative size of implied sets; we need to track how representations of singleness or multitude imply temporal and event-situational details.

Against this backdrop, *Student after student complained* captures both dimensions, implying both a widespread unrest among the student body and also temporal recurrence of complainings. By way of illustration, Figure 3 shows a deconstructing in the fashion of Dependency Grammar, along with implicit type annotations. As this shows, the “Student after Student” idiom can be notated as, say, $\text{after} :: N^\circ \rightarrow N^\circ \rightarrow N^+$ (using N° and N^+ to mean singular and count-plural nouns, respectively), but with the special case that the “argument” to *after* is repeated in both positions, suggesting an unusual degree of repetition, something frustratingly recurrent: *He went on and on*; *Car after car passed us by*; *Time after time I got turned down*. Although I have no problem treating these constructions as idiomatic plurals, I also contend (on the premise of phrase-overlap) that the dependent constituents in the —after— construction can be hooked to other phrases as well (which is why “and [their/his/her] parents” can also be singular, in this case). I dwell on this example because it shows how type/functional accounts of phrase structure can be useful even if we treat phrases more as frames which overlay linguistic structure, not as rigid compositional isolates. Each “students” variation uses morphology to nudge cognitive attention in one direction or another, toward events or the degree to which events are representative of some global property (here of a student body), or both. The $N^\circ \rightarrow N^+$ transformation is not *the* morphosyntactic meaning, but instead the skeleton on which the full meaning (via cognitive schema) is designed.

If this analysis has merit, it suggests that an ACG or type-logical approach to phrases like *many students* or *student after student* (singular-to-plural or plural-to-plural mappings) should be understood not just as functions among Part of Speech (POS) types but as adding cognitive shading, foregrounding or backgrounding cognitive elements like events or typicality in some context. In other words, *many students* is type-theoretically $N \rightarrow N$ or $N^+ \rightarrow N^+$; but, in more detail, it adds a kind of cognitive rider attached to the mapping which focuses cognition in the subsequent discourse onto events (their recurrence and temporal distribution); similarly “student after student” has a “rider” suggesting more of a temporal unfolding. The second form implies not only that many students complained, but that the events of these complainings were spread out over some stretch of time. Each such functional application (mappings between POS understood as linguistic

Figure 3: Dependency-style graph with argument repetition



types) produces not only a resulting POS “type”, but also a reconfiguration of cognitive attitudes toward the relevant situation and context. Language users have many ways to craft a sentence with similar meanings, and arguably one task for linguistic analysis is to model the space of choices which are available in a given situation and represent what specific ideas and effects are invoked by one choice over others.

4.3 Types, Sets, and Concepts

In formal/computational contexts, types can be defined as sets of both values and “expectations” [?] (meaning assumptions which may be made about all values covered by the type); alternatively, we can (perhaps better) consider types as *spaces* of values. Types’ extensions have internal structure; there can be “null” or “invalid” values, default-constructed values, and so forth, which are “regions” of the conceptual space spanned or encompassing types.⁹ There is definitional interdependence between types and functions: a function is defined in terms of the types it accepts as parameters and returns — rather than its entire set of possible inputs and outputs, which can

vary across computing environments.¹⁰ These are some reasons why in theoretical Computer Science types are not “reduced” to underlying sets; instead, extensions are sometimes complex spaces that model states of, or internal organization of comparisons among, type instances.

An obvious paradigm is organizing type-extensions around prototype/borderline cases — there are instances which are clear examples of types and ones whose classification is dubious. I contend, however, that common resemblance is not always a good marker for types being well-conceived — many useful concepts are common precisely because they cover many cases, which makes defining “prototypes” or “common properties” misleading. Also, sometimes the clearest “representative” example of a type or concept is actually not a *typical* example: a sample letter or model home is actually not (in many cases) a real letter or home. So resemblance-to-prototype is at best one kind of “inner organization” of concepts’ and types’ spaces of extension.

Sets, concepts, and types represent three different primordial thought-vehicles for grounding notions of logic and meaning. To organize systems around *sets* is to forefront notions of inclusion, exclusion, extension, and intersection, which are also formally essential to mathematical logic and undergird the

⁹Conceptual Space theory is outside the scope of this paper, but I’ll note that it suggests a promising link between natural linguistics and formal/computational type theory, as suggested by computational or scientific expositions of the original Conceptual Space account developed by Peter Gärdenfors: cf. [13], [1] [2], [?]. Meanwhile, projects to develop formal models for Cognitive Grammar have also adopted Conceptual Space theory as an underlying semantics: [14], [15], [30], [12].

¹⁰Moreover, expectations in a particular case may be more precise than what is implied by the type itself — it is erroneous to assume that a proper type system will allow a correct “set of values” to be stipulated for each point in a computation (the kind of contract enforced via by documentation and unit testing). So state-space in a given context may include many “unreasonable” values, implying that within the overall space there is a “reasonable” subspace, except that this subspace may not be crisply defined.

classical interdependence of sets, logic, and mathematics. To organize systems around *concepts* is to forefront practical engagement and how we mold conceptual profiles, as collections of ideas and pragmas, to empirical situations. To organize systems around *types* is to forefront “functions” or transformations which operate on typed values, the interrelationships between different types (like subtypes and inclusion — a type can itself encompass multiple values of other types), and the conceptual abstraction of types themselves from the actual sets of values they may exhibit in different environments. Sets and types are formal, abstract phenomena; whereas concepts are characterized by gradations of applicability, and play flexible roles in thought and language. The cognitive role of concepts can be discussed with some rigor, but there is a complex interplay of cognitive schema and practical engagements which would have to be meticulously sketched in many real-world scenarios, if our goal were to translate conceptual reasoning to formal structures on a case-by-case basis. We can, however, consider in general terms how type-theoretic semantics can capture conceptual structures as part of the overall transitioning of thoughts to language.

A concept does not merely package up a definition, like “restaurant” as “a place to order food”; instead concepts link up with other concepts as tools for describing and participating in situations. Concepts are associated with “scripts” of discourse and action, and find their range of application through a variegated pragmatic scope. We should be careful not to overlook these pragmatics, and assume that conceptual structures can be simplistically translated to formal models. Cognitive Linguistics critiques Set-Theoretic or Modal Logic reductionism (where a concept is just a set of instances, or an extension across different possible worlds) — George Lakoff and Mark Johnson, prominently, argue for concepts’ organization around prototypes ([18, p. 18]; [16, p. 171, or p. xi]) and embodied/enactive patterns of interaction ([18, p. 90]; [16, p. 208]). Types, by contrast, at least in linguistic applications of type theory, are abstractions defined in large part by quasi-functional notions of phrase structure. Nevertheless, the *patterns* of how types may inter-relate (mass-noun or count-noun, sentient or non-sentient, and so forth) provide an infrastructure for conceptual understandings to be encoded in language — specifically, to be signaled by which typed articulations conversants choose to use. A concept like *restaurant* enters language with a collection of understood qualities (social phenomena, with some notion of spatial location and being a “place”, etc.) that in turn can be marshaled by sets of allowed or disallowed phrasal combinations, whose parameters can be given type-like descriptions. Types, in this sense, are not direct expressions of concepts but vehicles for introducing concepts into language.

Concepts (and types also) are not cognitively the same as their extension — the concept *restaurant*, I believe, is distinct from concepts like *all restaurants* or *the set of all restaurants*.

This is for several reasons. First, concepts can be pairwise different not only through their instances, but because they highlight different sets of attributes or indicators. The concepts “American President” and “Commander in Chief” refer to the same person, but the latter foregrounds a military role. Formal Concept Analysis considers *extensions* and “properties” — suggestive indicators that inhere in each instance — as jointly (and co-dependently) determinate: concepts are formally a synthesis of instance-sets and property-sets [?], [8], [37]. Second, in language, clear evidence for the contrast between *intension* and *extension* comes from phrase structure: certain constructions specifically refer to concept-extension, triggering a mental shift from thinking of the concept as a schema or prototype to thinking of its extension (maybe in some context). Compare:

- ▼ (127) Rhinos in that park are threatened by poachers.
- ▼ (128) Young rhinos are threatened by poachers.

Both sentences focus a conceptual lens in greater detail than *rhino* in general, but the second does so more intensionally, by adding an extra indicative criterion; while the former does so extensionally, using a phrase-structure designed to operate on and narrow our mental construal of “the set of all rhinos”, in the sense of *existing* rhinos, their physical place and habitat, as opposed to the “abstract” (or “universal”) type. So there is a familiar semantic pattern which mentally transitions from a lexical type to its extension and then extension-narrowing — an interpretation that, if accepted, clearly shows a different mental role for concepts of concepts’ *extension* than the concepts themselves.¹¹

Concepts, in short, do not mentally signify sets, or extensions, or sets-of-shared-properties. Concepts, rather, are cognitive/dialogic tools. Each concept-choice, as presentation device, invites its own follow-up. *Restaurant* or *house* have meaning not via idealized mental pictures, or proto-schema, but via kinds of things we do (eat, live), of conversations we have, of qualities we deem relevant. Concepts do not have to paint a complete picture, because we use them as part of ongoing situations — in language, ongoing conversations. Narrow concepts — which may best exemplify “logical” models of concepts as resemblance-spaces or as rigid designators to natural kinds — have, in practice, fewer use-cases *because* there are fewer chances for elaboration. Very broad concepts,

¹¹There is a type-theoretic correspondence between intension and extension — for a type *t* there is a corresponding “higher-order” type of *sets* whose members are *t* (related constructions are the type of *ordered sequences* of *t*; unordered collections of *t* allowing repetition; and stacks, queues, and dequeues — double-ended queues — as *t*-lists that can grow or shrink at their beginning and/or end). If we take this (higher-order) type gloss seriously, the extension of a concept is not its *meaning*, but a different, albeit interrelated concept. Extension is not definition. *Rhino* does not mean *all rhinos* (or *all possible rhinos*) — though arguably there are concepts *all rhinos* and *all restaurants* (etc.) along with the concepts *rhino* and *restaurant*.

on the other hand, can have, in context, too *little* built-in *a priori* detail. (We say “restaurant” more often than *eatery*, and more often than *diner*, *steakhouse*, or *taqueria*). Concepts dynamically play against each other, making “spaces” where different niches of meaning, including levels of precision, converge as site for one or another. Speakers need freedom to choose finer or coarser grain, so concepts are profligate, but the most oft-used trend toward middle ground, neither too narrow nor too broad. *Restaurant* or *house* are useful because they are noncommittal, inviting more detail. These dynamics govern the flow of inter-concept relations (disjointness, subtypes, partonymy, etc.).

Concepts are not rigid formulae (like instance-sets or even attributes fixing when they apply); they are mental gadgets to initiate and guide dialog. Importantly, this contradicts the idea that concepts are unified around instances’ similarity (to each other or to some hypothetical prototype): concepts have avenues for contrasting different examples, invoking a “script” for further elaboration, or for building temporary filters. In, say,

- ▼ (129) Let’s find a restaurant that’s family-friendly.

allowing such one-off narrowing is a feature of the concept’s flexibility.

In essence: no less important, than acknowledged similarities across all instances, are well-rehearsed ways vis-à-vis each concept to narrow scope by marshaling lines of *contrast*, of *dissimilarity*. A *house* is obviously different from a *skyscraper* or a *tent*, and better resembles other houses; but there are also more nontrivial *comparisons* between houses, than between a house and a skyscraper or a tent. Concepts are not only spaces of similarity, but of *meaningful kinds of differences*.

To this account of conceptual breadth we can add the conceptual matrix spanned by various (maybe overlapping) word-senses: to *fly*, for example, names not a single concept, but a family of concepts all related to airborne travel. Variations highlight different features: the path of flight (*fly to Korea*, *fly over the mountain*); the means (*fly Korean air*, *that model flew during World War II*); the cause (*sent flying (by an explosion)*, *the bird flew away (after a loud noise)*, *leaves flying in the wind*). Words allow different use-contexts to the degree that their various *senses* offer an inventory of aspects for highlighting by *morphosyntactic* convention. Someone who says *I hate to fly* is not heard to dislike hand-gliding or jumping off mountains.¹² Accordant variations of cognitive

¹²People, unlike birds, do not fly — so the verb, used intransitively (not flying to somewhere in particular or *in* something in particular), is understood to refer less to the physical motion and more to the socially sanctioned phenomenon of buying a seat on a scheduled flight on an airplane. The construction highlights the procedural and commercial dimension, not the physical mechanism and spatial path. But it does so *because* we know human flight is unnatural: we can poetically describe how the sky is filled with flying leaves or birds, but not “flying people”,

construal (attending more to mode of action, or path, or motives, etc.), which are elsewhere signaled by grammatic choices, are also spanned by a conceptual space innate to a given word: senses are finer-grained meanings availing themselves to one construal or another.

So situational construals can be signaled by word- and/or syntactic form choice (locative, benefactive, direct and indirect object constructions, and so forth). Whereas conceptual organization often functions by establishing classifications, and/or invoking “scripts” of dialogic elaboration, cognitive structure tends to apply more to our attention focusing on particular objects, sets of objects, events, or aspects of events or situations. So the contrast between singular, mass-multiples, and count-multiples, among nouns, depends on cognitive construal of the behavior of the referent in question (if singular, its propensity to act or be conceived as an integral whole; if multiple, its disposition to either be divisible into discrete units, or not). Or, events can be construed in terms of their causes (their conditions at the outset), or their goals (their conditions at the conclusion), or their means (their conditions in the interim). Compare *attaching* something to a wall (means-focused) to *hanging* something on a wall (ends-focused); *baking* a cake (cause-focus: putting a cake in the oven with deliberate intent to cook it) to *burning* a cake (accidentally overcooking it).¹³ These variations are not random assortments of polysemous words’ senses: they are, instead, rather predictably distributed according to speakers’ context-specific knowledge and motives.

I claim therefore that *concepts* enter language complexly, influenced by conceptual *spaces* and multi-dimensional semantic and syntactic selection-spaces. Concepts are not simplistically “encoded” by types, as if for each concept there is a linguistic or lexical type that just disquotationally references it — that the type “rhino” means the concept *rhino* (“type” in the sense that type-theoretic semantics would model lexical data according to type-theoretic rules, such as *rhino* as subtype of *animal* or *living thing*). Cognitive schema, at least in the terms I just laid out, select particularly important gestalt principles (force dynamics, spatial frames, action-intention) and isolate

even if we are nearby an airport.

¹³We can express an intent to bake someone a cake, but not (well, maybe comedically) to *burn* someone a cake (“burn”, at least in this context, implies something not intended); however, we *can* say “I burnt your cake”, while it is a little jarring to say “I baked your cake” — the possessive implies that some specific cake is being talked about, and there is less apparent reason to focus on one particular stage of its preparation (the baking) once it is done. I *will* bake a cake, in the future, uses “bake” to mean also other steps in preparation (like “make”), while, in the present, “the cake *is* baking” emphasizes more its actual time in the oven. I *baked your cake* seems to focus (rather unexpectedly) on this specific stage even after it is completed, whereas *I baked you a cake*, which is worded as if the recipient did not know about the cake ahead of time, apparently uses “bake” in the broader sense of “made”, not just “cooked in an oven”. Words’ senses mutate in relation to the kinds of situations where they are used — why else would *bake* mean “make”/“prepare” in the past or future tense but “cook”/“heat” in the present?

these from a conceptual matrix. On this basis, we can argue that these schemata form a precondition for concept-to-type association; or, in the opposite logical direction, that language users' choices to employ particular type articulations follow forth from their prelinguistic cognizing of practical scenarios as this emerges out of collections of concepts used to form a basic understanding of and self-positioning within them.

In this sense I called types “vehicles” for concepts: not that types *denote* concepts but that they (metaphorically) “carry” concepts into language. “Carrying” is enabled by types' semi-formal rule-bound interactions with other types, which are positioned to capture concepts' variations and relations with other concepts.

To express a noun in the benefactive case, for example, which can be seen as attributing to it a linguistic type consistent with being the target of a benefactive, is to capture the concept in a type-theoretic gloss. It tells us, I'm thinking about this thing in such a way that it *can* take a benefactive (the type formalism attempting to capture that “such a way”). A concept-to-type “map”, as I just suggested, is mediated (in experience and practical reasoning) by cognitive organizations; when (social, embodied) enactions take linguistic form, these organizing principles can be encoded in how speakers apply morphosyntactic rules.

So the linguistic structures, which I propose can be formally modeled by a kind of type theory, work communicatively as carriers and thereby signifiers of cognitive attitudes. The type is a vehicle for the concept because it takes part in constructions which express conceptual details — the details don't emerge merely by virtue of the type itself. I am not arguing for a neat concept-to-type correspondence; instead, a type system provides a “formal substrate” that models (with some abstraction and simplification) how properties of individual concepts translate (via cognitive-schematic intermediaries) to their manifestation in both semantics and syntax.

Continuing with declension as a case study, consider how an “ontology” of word senses can interrelate with the benefactive. A noun as a benefactive target most often is a person or some other sentient/animate being; an inanimate benefactive is most likely something artificial and constructed (cf., *I got the car new tires*). How readily hearers accept a sentence — and the path they take to construing its meaning so as to make it grammatically acceptable — involves interlocking morphological and type-related considerations; in the current example, the mixture of benefactive case and which noun “type” (assuming a basic division of nouns into e.g. animate/constructed/natural) forces a broader or narrower interpretation. A benefactive with an “artifact” noun, for example, almost forces the thing to be heard as somehow disrepaired:

- ▼ (130) I got glue for your daughter.

- ▼ (131) I got glue for your coffee mug.

We gather (in the second case) that the mug is broken — but this is never spelled out by any lexical choice; it is implied indirectly by using benefactive case. It is easy to design similar examples with other cases: a locative construction rarely targets “sentient” nouns, so in

- ▼ (132) We're going to Grandma!
- ▼ (133) Let's go to him right now.
- ▼ (134) Let's go to the lawyers.
- ▼ (135) Let's go to the press.

we mentally substitute the person with the place where they live or work.

Morphosyntactic considerations are also at play: *to the lawyers* makes “go” sound more like “consult with”, partly because of the definite article (*the* lawyers implies conversants have some prior involvement with specific lawyers or else are using the phrase metonymically, as in “go to court” or “to the courts”, for legal institutions generally; either reading draws attention away from literal spatial implications of “go”). *Go to him* implies that “he” needs some kind of help, because if the speaker just meant going to wherever he's at, she probably would have said that instead.

Similarly, the locative in *to the press* forces the mind to reconfigure the landmark/trajector structure, where *going* is thought not as a literal spatial path and *press* not a literal destination — in other words, the phrase must be read as a metaphor. But the “metaphor” here is not “idiomatic” or removed from linguistic rules (based on mental resemblance, not language structure); here it clearly works off of formal language patterns: the landmark/trajector relation is read abstracted from literal spatial movement because the locative is applied to an expression (*the press*) which does not (simplicistically) meet the expected interpretation as “designation of place”. In short, there are two different levels of *granularity* where we can look for agreement requirements: a more fine-grained level where e.g. *locative* draws in a type-specification of a *place* or *location*; and a coarser level oriented toward Parts of Speech, and typologies of phrasal units. The former analysis addresses the level I have called “macrotypes”, while the latter scale is at the “macrotype” level.

I envision the unfolding that I have just sketched out as something Phenomenological — it arises from a unified and subjective consciousness, one marked by embodied personal identity and social situation. If there are structural stases that can be found in this temporality of experience, these are not constitutive of conscious reality but a mesh of rationality that supports it, like the veins in a leaf. Structural configurations can be lifted from language insofar as it is a conscious, formally governed activity, and lifted from the ambient situations which lend language context and meaning intents. So any analytic

emphasis on structural fixpoints threaded through the lived temporality of consciousness is an abstraction, but one that is deliberate and necessary if we want to make scientific or in any other manner disputable claims about how language and cognition works.

To return to the example of *Student after student*, I commented that designating one word to “represent” the phrase seemed arbitrary. If we consider functional-typing alone, *after* is the only non-noun, the natural conclusion is that “after” should be typed $N \rightarrow N \rightarrow N$ (which implies that “after” is analogous to the “functional” position, and in a lambda-calculus style reconstruction would be considered the “head” — Figure 3 is an example of how the sentence could be annotated, for sake of discussion). This particular idiom depends however on the two constituent nouns being the same word (a pattern I’ve also alluded to with idioms like *time after time*). Technically, this appears to be an example of *dependent types*: specifically, a type-theoretic model of *after* in this would seem to require that the $N \rightarrow N \rightarrow N$ signature be constrained so that the second noun matches the first — so the second N type is actually constrained to be a singleton type dependent on the first N ’s value. On that account, the parameters for *after* are a dependent type pair [5], [32] satisfied by an identity comparison between the two nouns. This analysis captures a type-theoretic gloss on the structural contrast between *Student after student* and *Many students*, phrases which are similar but not identical in meaning (so whose differences need explaining).

I have offered a more cognitive account focusing on the implicit temporality of *Student after student*; this later type-oriented model is more formal, or at least leaves open the possibility that language is organically taking in structures engineered into artificial (e.g., computer programming) languages. It is certainly possible to witness formalizable structures in language patterns — Zhaohui Luo finds strong evidence for dependent types being a good model for semantic norms in [22], for example. Whether these kinds of formalisms have important causal influence on language acquiring its evident patterns, or are more like just convenient representational tools, is perhaps an open (and maybe case-by-case) question.

Consider alternatives for “many students”. The phrase as written suggests a type signature (with “many” as the “function-like” or derivative type) $N^+ \rightarrow N^+$, yielding a syntactic interpretation of the phrase; this interpretation also suggests a semantic progression, an accretion of intended detail. From *students* to *many students* is a conversion between two plural nouns (at the level of concepts and semantic roles); but it also implies relative size, so it implies some *other* plural, some still larger group of students from which “many” are selected. While rather abstract and formal, the $N^+ \rightarrow N^+$ representation points toward a more cognitive grounding which

considers this “function” as a form of thought-operation; a refinement of a situational model, descriptive resolution, and so forth. If we are prepared to accept a cognitive underpinning to semantic classification, we can make the intuition of part of speech signatures as “functions” more concrete: in response to what “many” (for example) is a function of, we can say a function of propositional attitude, cognitive schema, or attentional focus.

The schema which usefully captures the sense and picture of *students* is distinct (but arguably a variation on) that for *many students*, and there is a “mental operation” triggered by the *many students* construction which “maps” the first to the second. Similarly, *student after student* triggers a “scheme evolution” which involves a more explicit temporal unfolding (in contrast to how *many students* instead involves a more explicit quantitative *many/all* relation). What these examples show is that associating parts of speech with type signatures is not just a formal fiat, which “works” representationally but does not necessarily capture deeper patterns of meaning. Instead, I would argue, type signatures and their resonance into linkage acceptability structures (like singular/plural and mass/count agreement) *point toward* the effects of cognitive schema on what we consider meaningful.

In *Student after student came out against the proposal*, to *come out*, for/against, lies in the semantic frame of attitude and expression (it requires a mental agent, for example), but its reception carries a trace of spatial form: to come out *to* a public place, to go on record with an opinion (I analyzed this case in Section 2). Usually “come out [for/against]”, in the context of a policy or idea, is similarly metaphorical. But the concrete spatial interpretation remains latent, as a kind of residue on even this abstract rendition, and the spatial undercurrent is poised to emerge as more literal, should the context warrant. However literally or metaphorically the “space” of the “coming out” is understood, however explicit or latent its cogitative figuration, is not something internal to the language; it is a potentiality which will present in different ways in different circumstances. This is not to say that it is something apart from linguistic meaning, but it shows how linguistic meaning lies neither in abstract structure alone, nor contextual pragmatics, but in their cross-reference.

5 Conclusion

Of the three type levels I have proposed, the macrotype “functional” level is the most quasi-mathematical; for other levels, formal type theory may provide interpretive tools and methodological guides, but formally representable framings and transformations may be only approximations of how peo-

ple actually think, while they are understanding language. From this perspective, we are left with the metatheoretical question of clarifying how different kinds of analyses, which put different degrees of weight on formal or on interpretive argumentation, are to be joined in overarching theories. In particular, are the linguistic phenomena which seem to demand more “interpretive” treatment actually beyond formalization, or is it just impractical (but possible in theory) to provide formal analysis of each individual case-study, each real-world language formation? Is Natural Language actually no less formal than (for example) computer programming languages, except that the former have a much larger set of semantic and syntactic rules such that any analysis can uncover them only partially? Or is any rule-based model of language, no matter how complete, necessarily partial relative to real language?

We can consider at what point formal and computational methods reach a limit, beyond which they fail to capture the richness and expressiveness of Natural Language, or whether this limit itself is an illusion — whether even fully human language competence is (perhaps in principle if not in practice) no less reducible to formalizable patterns. Whatever one’s beliefs on this last question, a progression of subdisciplines — from formal-logical semantics through programming languages and computational Natural Language Processing — is a reasonable scaffolding for a universe of formal methods that can build up, by progressive theoretical sophistication or assembly of distinct analyses which piece together jigsaw-like, to model real-world language understanding. Perhaps real language is an “emergent property” of many distinct algorithms that run and combine in the mind; or perhaps the relevant algorithms are a precondition, presenting cognition with essential signifying givens but fleshed out in other, more holistic ways, as we become conscious of language not just as a formal system but an interactive social reality.

I have claimed that Cognitive Transform Grammar aims toward a theoretic nexus that plugs into several syntactic and semantic methodologies. Both Dependency Grammar word-pairs and functional type-attributions on lexemes (together with their “arguments”) can be interpreted as Cognitive transforms. By itself, the superposition of type-theoretic semantics on link-grammar graphs does not cross a hypothetical “barrier” between the formal and the cognitive. But I intend here to suggest a cognitive *interpretation* for the formal structures; that they represent an outline of cognitive schema, or progressions, or represent linguistic “triggers” that a cognitive language ability (taking language as part of an environing world and produced by others, in rule-bound social situations, to communicate ideas and sentiments) responds to. This range of interpretations is deliberately open-ended: we can say that a formal infrastructure grounds the cognitive reception of language givens, without arguing specifically that formal structures identified in language therefore model cognitive operations directly, or that these are instead patterns

identified in language that trigger a cognitive response, or any other paradigm for mapping cognition as process and activity to language structure as model and prototype. Leaving these options open, however, I will focus in the remainder of this paper on one interpretation, considering formal structures as “triggers” which get absorbed into language understanding via observatory propensities: as language users (on this proposal) we are disposed to identify certain formal structurations operating in language as we encounter it, and respond to these observations by building or refining mental models of the situations and signifying intentions we believe have been implied by the discourse, in evolving and intersubjective dialogic settings that involve joint practical activity as well as communication.

In this sense, I believe natural language reveals mutually-modifying juxtapositions of concepts whose full semantic effects are probably not “computable”: I would work on the assumption that language *as a whole* and as human social phenomena are the precinct of a cultural fluency *beyond* Natural Language Processing. The aforementioned “linguistic side effects” can be *modeled* by tracing our reception of linguistic meaning through syntactic and semantic formations, like Dependency Grammar and Type Theory, but I argue for such models not as models *of* cognitive processes, but rather models of *observations* which trigger cognitive follow-up. Even if we believe in and practice a rigorous formalization of morphosyntactic structure, where the *pattern* of conceptual “side-effects” can be seen as unfolding in algorithmic ways, the cognitive *details* of these effects are too situational, and phenomenologically rich, for computability as ordinarily understood.

But the formal structure is not wholly irrelevant: to call up nuanced cognitive schema — or so I submit for consideration — may not be possible without algorithmically reproducible lexicosemantic and morphosyntactic triggers, at least modulo some approximation. A (perhaps non-computable) space of cognitive schema may be projected onto a (perhaps computable) set of affiliated morphological patterns, using notations like link-grammar pairs and type signatures to catalog them. For example, there may be a non-computable expanse of possible construals of pluralization; but any such construal, in context, is called into focus in conversants’ minds by morphosyntactic invitations, by speakers’ choices of, say, $N^{\circ} \rightarrow N^{+}$ -pattern phrases. The important balance is to take formalization as far as is reasonable without being seduced into logico-symbolic reductionism.

Any word or usage invites various facets to either emphasize or deemphasize, and these subsumed concepts or foci are latent in potential meanings, brought into linguistic space by the play of differentiation¹⁴ : *baked*, not *made*; *flew*, not *traveled*; *spill*,

¹⁴ Alluding, in part, to Sausurrean “system of differences” [25, p. 15] — to choose a reference which introduces Sausurre in a rather unexpected

not *pour*. These under-currents of subsidiary concepts and foci are selectively hooked onto by morphosyntactic selection, so in analyzing phrase structure we also have to consider how using syntax which constructs a given structure also brings to the forefront certain nested concepts and construals, which are latent in word-sense options; in the topos of lexicosemantic possibilities.

So, any talk about “side effects” of morphosyntactic functions — mapping verb-space to adjective-space, noun-space to proposition-space, singularity to plurality, and so forth — should consider a type-theoretic gloss like $N \rightarrow N$ as sketching just the motivating scaffold around an act of cognitive refocusing. The interesting semantics lies with *how* a sense crosses over, in conversants’ minds, to some other sense or concept, wherein other aspects are foregrounded — for example, within temporal event plurality: multiplicity as frequency, or episodic distribution relative to some time span; or suggesting something that is typical or predominant; or relative count against some other totality — each such refocusing triggered by a phrasal construction of the form $N \rightarrow N^+$ or $N^+ \rightarrow N^+$. Or we can map singulars, or count plurals, to mass nouns, and vice-versa (*shrubs* become *foliage*; *water* becomes *a glass of water*). The plural and the singular are a coarse-grained semantic that has not yet arrived as *meaning*. Conceptual spaces guide attention to classes and properties, defining a path of ascending precision as speakers add descriptive detail; cognitive construals negotiate relations between different kinds of aggregates/individuals; individuality, aggregation and multiplicity as phenomena and disposition. These construals are practical and embodied, *and* phenomenological — they direct attention (*qua* transcendental universal of mentality, if we like), to and fro, but in the course of intersubjective and goal-driven practical action (and in that sense particular, world-bound, historicized).

Linguistically, the “effects” of language “functions” are mutations/modifications in cognitive state, resonant to concrete or abstract scenarios which are topics of dialog. Sometimes, effects may tolerate mathematical analysis; but such analytical thematics tend to peter out into the ambient, chaotic worldliness of human consciousness.

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