Cognitive State Semantics and the Interface Theory of Meaning

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Abstract

Start with the question of conditions of possibility for language to exist: how spoken, written, or inscribed signs differ from other kinds of things, enough to establish language as something that exists in the world. Language is a regime of multiple conversation partners, an ambient surrounding where they share actions, perceptions, and foci of attention, and a common posit of structured rules. If communication is successful, each sign's referent is isolated, collectively/phenomenologically, from a (canonically spatiotemporal) reality that extends beyond it. My goal here is to sketch this process with the help of formal and Computational linguistic theories, but keeping in sight a cognitive nuance and intersubjectivity that is (thankfully) an essential, unavoidable part of human language. I will incorporate technical models mostly from Link Grammar and Type-Theoretic Semantics, understanding the latter as possibly layering on the former to complete a syntax/semantic pairing. I propose both cases for and limits on formal theories' applicability for Cognitive Linguistics/Humanities/Phenomenology, through the lens of the Philosophy of Science — arguing how Phenomenology and Cognitive Linguistics, while distinct traditions, can work powerfully in consort.

> 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, *Syntaxe Topologique et Grammaire Cognitive*

> 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, *Mind World*

A sign demands an individuation — a criteriology, for anyone addressed and solicited by each sign, to recognize and isolate it as such. Signs, and their referents, need an isolating, from the world around (and one another), or they are not signs. In extreme cases a sign may stand alone, like the smoke fire telling a hiker's location; but by norm, embedded in discourse and performance, signs require (and carry with them, internally) understood inter-boundaries. Both the recognition and the interpretation of signs therefore implicates cognition-logics of part/whole (mereology), and (dis/)continuity, each sign/referent disconnected in some ways, and continuous in others, with larger wholes inside which they are semi-autonomous parts.

Ad-hoc signs can blur the boundaries between conventionalized languages (verbal or not) and more impromptu social interactions — the smoke fire is in part a conventional distress signal and in part a tool, an engineered natural phenomenon designed with intended effect, like causing rescuers to see it. The distress fire is also in a sense its own referent: its function as a sign is to call attention to itself, and so its location. Or, choosing to write on one's own body — like Hamas commander Mahmoud Ishtiwi, betrayed and killed by his own movement, carving into his leg the word "zulum" ("wronged") — is expression spreading beyond the conventions of words; the signs are made to signify the conditions of their ex-

ecution. These rather dramatic examples are more the provenance of semiotics than linguistics. But people in ordinary verbal communication equally rely on a mixture of linguistic and other signs — we point, make gestures, use "body language" and tone of voice. When conversation turns to some topic, like "that building over there", such cues help speakers synchronize their attentions. Tone and gestures clarify sentiment (honest, joking, sarcastic, anger) that may be ambiguous in spoken words alone, taken "out of context". The weight of linguistic meaning is borne by semantics and pragmatics in fusion. Semantics has both formal and informal dimensions — linking first to cognitive schema, or (as I will argue) prototypes of how schema are triggered; and second to pragmatics and contexts. Conventionalized in semantic norms, schema, part abstract and part cognitive, help prime language users to manipulate formal structures in language, relative to the situational aether. (Dis/)continuity in the plane of reference brings consciousness to a mereo-logic [23], [61] that language-cognition can then reshape into syntax and semantics [8]. Semantic layers are abstract tools, but they offer a tableau of forms and combinations which users adapt, concretely, to each context. The deep potential of language, I believe, comes from the perpetual combination of the formal/abstract and the concrete/phenomenological.

For signs, the largest whole is a "plane" of articulation; for referents, it is an overall phenomenological surround; or, for more abstract signifieds, a space of concepts. Like a footprint, whose very existence depends on both material continuity and visual break, for each sign there must be a blend of continuity and discontinuity, both around the sign and its referent. Attending to a mereologically ordered world, we need innate theories warranting criteria for seeing things as both individuals and as causally/behaviorally constrained by and from a whole. These criteria include structural consideration of the whole, and it is often in structural terms that the blend of autonomy and linkage for each part is realized. Attunement to structured organization therefore warrants the perceptual and mental isolation of particular foci of attention [75], [76].

As this plays out on planes of articulation alongside general situational awareness, the structures of discourse — its division into distinct signs and their structural interrelationships — and that of patterns we identify in our surroundings, that provide a context of discourse, play off one another. Grammar does not iconify interrelationships among referents — unlike diagrams, maps, scientific simulations, or scale models — but it ensures communicators may create structures among words that suggest, in each others' minds, concordant patterns in the environing world/situation. Even where there is direct sensory and perceptual evidence for objects' individuation and intercontinuity, visually and experientially present (which of course is only one kind of talk and reference), our preparedness to focus attention here or there depends on mental models of situations which are more abstract and schematic, and receptive to functional and interpersonal details. The objects around us are not just blobs of matter, but usually have a constructed purpose, socially sanctioned meaning, nostalgic weight, and other significance that cannot be grasped by perception alone.

A central theme in Cognitive Linguistics is that language meaning depends on situational understanding, and by extension on mental schema of spatial, temporal, and functional organization — not only how environments are arranged, but how they are causally and physically determined [52], [67]. The difference between *pour water* and *spill water*, for example, is the person's deliberate intentions in relation to natural forces and tendencies (such as that of water to fall downward). To "apply paint" to something, compared with to "cover" with paint, suggests different spatial configurations; to *fill a glass with water*, versus *pour water into* the glass, suggests both different spatial details and maybe rationale as well. These are differences in emphasis, not necessarily in actuality: those pairs of alternatives could describe identical state of affairs. But they direct conversants' attention in different ways, they choose one or another part of a scene as a reference frame, and suggest different "takes". These are driven by *semantic* variations — the choice of verbs like *pour* versus *fill*, *pour* versus *spill*, or *apply* versus *cover*. But semantic and syntactic rules work in federation, relative to context: for example, different verbs take different prepositions in different situations. Pour *into* vs. fill *with*. To join "pour" with *with* places emphasis elsewhere — onto the device which enables the pourer to do the pouring. So the grammatic and semantic norms of a language jointly offer a terrain of options from which speakers assemble combinations invoking those aspects of situations that

they wish to emphasize.

In short, grammar is language's substitute for *visual* or *physical* resemblance-to-structure. Take Ronald Langacker's "landmark"/"trajector" model as an example: one (very general) manner of spatial gestalt, subject to either intuitive, reflective analysis or to formalization ([6], [74]). "That boat crossing the lake": *boat* (trajector) perceived against *lake* (landmark), which provides context; together they produce a mental model; a figured spatial relationship. This is communicated, not by visual or kinaesthetic effect,[1] but by the more abstract effects of intentions signaled, via both exact words ("crossing" paints a different picture than would *across*, *on*, *by*; still more so, *at the bottom of*), and morphosyntactic tropes (like the form x `r` y; where "`r`" here means one from many spatial relations, taking *trajector* to the left and *landmark* to the right). *Landmark* and *trajector* are anchors around which both syntactic and semantic selections are organized.

Language needs both abstract laws and cognitively-mediated construals of ambient situations. The abstract laws are shaped by the situations, not directly — it is that extra indirection which cleaves language from other sign systems — but derivatively: language rules are optimized for conversants to mold linguistic possibilities into selection-spaces, which then become raw materials for representations of situational context. Each choice of word and form adds a piece to a representational complex, and the sum of those pieces — be this a sentence, a conversation turn, or an entire discourse — is a language act that hews to the structure of a situation, as the speaker wants to emphasize it. Here I take this perspective as pregiven: not as a perfected or homogenous theory, but as a working hypothesis on the origins of linguistic structuration as such. The scope of this paper is then to analyze its ramifications for our understanding of grammar and formal semantics.

This essay adresses topics in linguistics and the philosophy of language, though (by conventional measures of expertise) I am more of a Phenomenologist and a Computer Programmer than a linguist. I confess this not as biography, but to introduce my metatheoretical anchor points, from which derive intuitions that others might find unconventional. I am, in particular, sensitive to the experiential nuances of human cognition and skeptical that mechanical systems can emulate human minds except for narrowly defined tasks. At the same time, I think computational systems have interesting aspects that can enrich our understanding of cognition, even if we do not philosophically buy a "cognition is computation" metaphor.

To be precise, I am skeptical about "AI"; and I am also skeptical about a kind of logical reductionism that I believe exerts a definitive influence on several interrelated filds, including philosophy, linguistics, and computer science. As the paradigm seemingly goes, if we accept some form of "mind as computer" analogy, then we intrinsically accept *first* the idea that "mind" encompasses as some important part a logically articulated subsystem, which can be scientifically studied via formal logic; and *second* that as a consequence of this scientifically tractable logicality, AI is a good model or proxy for the study of mind. The unconscious deduction here seems to be that *mind as computer* has as a consequence that mind is (to some salient degree) a logical system, following a premise that computers are logical systms. But this premise is more false than it is true; so for me the whole paradigm is on shaky grounds. I will explain later why computers are not as logical as non-programmers seemingly believe. For now I'll just say this: there are rigorous accounts of computation that, I contend, are not grounded on formal logic in any techical or reductive sense. As a result, someone's non-logical-reductive views on language and consciousness do not *a priori* preclude computational models having some intuitive, explanatory, or structural-analogy place in their analyses of cognition.

Meanwhile, on the Phenomenological menu I am a committed "realist". What I mean is that, in a nutshell, we should renew our commitment not to read Husserl too psychologically; for instance, not to read *intentionality* as a psychological phenomenon. If I see a red sofa, we should go ahead and accept that what I see is a red sofa — that very object. I do not see a mental image of a red sofa or a phenomenal appearance of a red sofa or a token of red-sofa-appearance-ness. We should not be led stray by the sofa being a few feet away from me, so it is not "in my brain". Yes, my brain is over here, not over there — If I am suddenly distracted by something, look away,

[1] At least in prose — poetry, which can bring back a semiotics of raw visual layout and auditory effect, is an exception that proves the rule.

and forget about the sofa, my sofa-impression (but not the sofa) goes away, which seems to suggest that there my sofa-impression is not the same kind of thing as a sofa — which in turn invites us to qustion whther what I am really seeing is that sofa-impression, not that sofa.

But, without disputing that in *some* sense the impression is not ontologically identical to the thing itself, I still maintain that the best gloss on the situation still starts from the givenness that I do see the sofa (and not the sofa-impression or any other psychologistic posit). I will have mor about to say about this realism, also. For now I'll say this: the case for "impressions" over "things themselves" seems stronger when talking about vision (which works at a distance) rather than touch — if I actually sit down on the sofa and physically contact it, we may feel more comfortable saying that my experience is directly encountering that physical object (though someone could still say that tactile sense-impressions are still not identical to objects; for one thing, the contact point between my hands/torso and the sofa — the locus of those haptic nerve cells — is not in my brain either, ergo a spatial gap still exists between brain and the sensed object). If we accept that our nervous system is in some sense a functionally organized complex, then an encounter between some external body and *part* of that system, with suitably holistic functional response, can plausibly be treated as "my brain" (or nervous system or mind) contacting the sofa — we don't need to rule out this gloss because my *central* nervous system remains physically isolated, any more than we would dispute that a knife has punctured a sealed carton when in fact only the knife-tip did so. In short, sense-causing physical contact as part of my embodied propensity to register tactile contact experientially, through the medium of functionally-organized processing that eventually includes the brain, is — I would say — a sensate manifestation of my contact with the sofa (not with a tactile-sense-impression or haptic-phenomenon of the sofa).

And if we accept this line of reasoning for touch, we should do so for vision also — partly because an intrinsic feature of *seing* something is that we *could* with proper movement touch it, and apprehension of visual from includes anticipation of how surfaces will respond when we kinaesthetically interact with them (we might presume, for instance, that we can run our hand over the wall to the right but not to the left, if there's another wall there: this visual disclosure is also in a sense proto-kinetic).

So, before making claims about language, I have hereby asserted two main intuitive feints guiding my subsequent discussion: computer programs as useful but not logically reductive analogs for cognitive processes, and the virtues of a "realist" Phenomenology which accepts language to the effect that we experience "things themselves": that touching and seeing (etc.) are expriential encounters with real, external, non-psychological entities. This does not have to be a blunt realism — I don't dispute that we experience appearances in some sense — but we need to articulate the thing/apearance distinction in a way that does not disallow common-sense intuitions like "seeing the sofa" meaning that I do see some real, external sofa-thing. That would make for an analysis in pure Phenomenology if I just framed my arguments with reference to, say, Husserl's own treatment of the noemata/phenomena distinction. Here, howevere, I am going in a different direction and package a loose theory of "realism" about intended "external" objects within a treatment of "externalism" (and *internalism*) in the philosophy of language.

I am not ignoring that "external" in the sense of "wide scope" mind-world relations as a Semantics hypothesis is only tangentially related to "external" in a phenomenological sense of experienced external objects (as opposed to experienced internal, e.g. somatic, states). But I *will* present a theory that connects these two senses of "external" (and likewise two senses of "internal").

All told, my goal here is to sketch a theory of cognitive linguistics which can resonate soundly with Phenomenology (while not being especially phenomenological on its own). This theory will be incomplete — deliberately, strategically incomplete. Indeed, every theory should be incomplete: an essential quality of modern science is our recognition that scientific explanation covers a vast breadth of scales and kinds of phenomena, and "science" as a singular human institution only exists insofar as there are many sciences, each with some measure of theoretical autonomy but also areas of overlap, so scientific explanations can bridge across scales. Bioligists take it for granted that the basic intellectual structures of their disciplines can be justified by appeal to chemistry (as a causative or emergent base of bioloigical phenomena);

and the presence of *parts* of biology where this connection is explicit (like organic chemistry) is important for our overall sense of biology as something grounded in a general scientific method. But these "reductive" links are not typically operationalized in biology as a whole — a biologist is not "doing" chemistry, biological properties are not necessarily chemical properties, biological laws are not necessarily chemical laws, and biological terms are not semantically (or even arguably referentially) reducible to chemical terms.

We can consider whether biological concepts are "in some sense" reducible to (or extensionally equivalent to or "the same stuff as") chemical concepts, but framing this discussion as a nuanced debate implies that biology is not *trivially* reducible to chemistry, and we may accept such a reduction as a plausible option only insofar as some of us may hold philosophical commitments, which "we" collectively do not want to dismiss out of hand, that higher-scale sciences are necssarily reducible to lower-scale ones that are their causal or physical-constitutive base. But even if there is a sense of "reduction" and of "biology" and "chemistry" that makes biology reducible to chemistry, this dos not make biological *science* reducible to chemical *science* — that is, a well-constructed and discursively evaluable biological theory should not be expected to consider in any detail its own reductive interprtations, or express its concepts in chemical (rather than biological) terms, or attempt to *explain* rather than just *presuppose* chemical laws (preservation of quantities in chemical reactions, acid/base qualities, solvents and solubility, molecular interactions, etc.). Ditto for chemistry in relation to molecular physics, molecular physics in relation to quantum physics, neurology in relation to biology, and so forth. In short, whatever our philosophical intuitions about emergent phenomena and the ontological duality (or monism) between emergent and base scales, these philosophical points are only tangentially related to the equally important philosophical question about what makes a good theory in a science.

This bears reiterating: when considering a science (I'll include social sciences and humanities here) philosophically, there are two different sorts of questions that can arise. On the one hand, what is the ontological status of the entities, laws, and quantitative models postulated by the science and its currently influential theories? Should we understand terms to be proposed natural kinds (like "protons"), structural features that don't necessarily align with straightforward patterns of reference (like "dark matter"), referring expressions into complex systems whose parts have somehow fuzzy or underdetermined boundaries or criteria of individuation (like "storms" in the context of climate science), or quasi-references which have the form of concrete designations but are really just shorthand for elaborate paradigms (like "natural selection")? These are various options in the semantics of scientific jargon, which are clues to the proper ontological status of scinces' theoretical posits (so much applies to linguistics also, with its theortical vocabulary of concepts, lexemes, syntax rules, generative semantic rules, and so forth — are these mental subsystms? Innate cognitive faculties? Clusters of nerve cells? Neural pathways reinforced during language acquisition?). But, on the other hand, there is a different order of question philosophers can ask with regard to a particular science: what qualifies as a well-constructed theory for that science? What sorts of formal models hold explanatory merit as, seemingly, capturing the casuative factors determining the behavior of the systems that science investigates: continuum-based numerical models? Models in discrete mathematics? Systems of logic? State machines? And interconnected with that question is the proper scope of the science: a well-constructed theory needs to honor bounaries between and autonomy of different sciences. Having a clear picture of what beliefs in *other* sciences to take as explanatory primitives in *this* science is an essential criteria of theoretical soundness — no less than the urge to pursue explanatory closure within the proper bounds of each science.

One of my objections to "logical reductive" paradigms in linguistics (and computer science) is their failure to distinguish these two aspects of a philosophy of science, by my lights. When discussing chemistry or biology, we can make a clear distinction between metaphysical commitments according to which higher-scale systems reduce (via physical composition and the propagation of causality across levels of organization) to lower ones — biology to chemistry to physics — as a genre of reduction obviously diffrent from reducing sciences as collective intellectual exercise. We do not reduce the community of biologists to the community of chemists, or the kinds of expertise and fluency in certain mental gymanastics, or the criteria of what makes good biological theories, to the concordant community, conceptualizations, gymnas-

tics, and theory-criteria of chemists. This is for me part of what makes biology a successful science — it is incomplete in an ontologically necessary, intellectual fertile way. But if this is a reasonable criterion, what can we say about linguistics as a science? Is it incomplete in an ontologically necessary and intellectually fertile way? In fact, I intend to argue here that some popular linguistic theories are *not incomplete enough*. They are (or would be, if successful) too complete — while also, I will claim, incomplete in the wrong ways, leaving too many *relevant* phenomena, issues that *are* in the scientific wheelhouse, incompletely explained.

I will make these arguments as a prelude to describing the (incomplete) linguistic theory I *am* prepared to defend. Specifically, the first two sections here will weigh in on Conceptual Role Semantics and Truth-Theoretic Semantics and explain why I believe some popular paradigms in the philosophy of language are problemmatic. While the details will vary, the main thurst of my points will be that philosophers of language fail to appreciate the importance of sciences internalizing a map of the division of labor between science — a science is constituted in part by how it touches but remains autonomouus from other (both higher- and lowe-scale) sciences. So biology is constituted in part by its status as a potential reductive base for (e.g.) neuroscience, medicine, genetics, and paleontology, while having its own reductive base in chemistry and physics. Part of what it means to be biology is to be the explanatory bridge between, say, medicine and physics.

Analogously, I believe, part of what it means to be linguistics is to be the explanatory bridge between, say, sociology, anthropology, and ethnolinguistics, with cognitive science (or Cognitive Phenomenology). Language can be intrinsically characterized as the cognitive bridge between our everyday world — of social situations and kinaesthetic/pragmatic enaction and anticipation, planning and memory — with the neurophysical substratum (whatver it is) of our mental faculties. Language, that is, is an important tool for our negotiating the duality of our higher-scale social/situational world with our lower-scale neurophysical existence. Analogously, a phenomenon in language — say, a sentence — should be analyzed as a kind of transition-system between a social/situational layer of reality and a cognitive/neurological layer. Linguistics is accordingly suspended between these layers — or, better, I claim that linguistics should be the *theory of being suspended* between social/situational and cognitive/neurological strata. A linguistic analysis starts with entities shooting in from the first stratum (sentences we hear uttered, canonicaly), and it ends with some restructured representation or consummation of that sentence (parsed, lexified, etc.) understood as inputs to some neurophysical process belonging (ontologically, and as a matter of scientific jurisdiction) to the second stratum. Such an analysis is *correctly* incomplete because it recognizes that a basic criterion of well-formdness for linguistic theories is that they *refrain from* direct analysis of either societal/interpersonal or cognitive/neurophysical processes. Linguistic analysis is incomplete because a theortical machinery fine-tuned for analyzing processes of linguistic understanding at the intermediate level between social/situational and neurological strata cannot be the same as a theortical machinery for analyzing either (in one explanatory direction) sociological or (in the other) neurophysical laws in turn — by analogy, the exeprimental (and theoretical) machinery for detecting Earthlike exoplanets cannot be the machinery for detecting Higgs bosons (and vice-versa).

Here I find an analogy to computer software useful: programs don't run themselves, so application developers realize that they do not control, or have access to much information about, when applications are launched (or when users will perform actions that require response from the software, like clicking a mouse button or pressing a key). Nor do programmers control input/output commands like emitting colors to the screen: they only influence electronic devices (like displays and networking capabilities) indirectly, via preimplemented system calls. In other words, the essential structure of a computer application is to be poised to react to various events (a mouse click, a key click, plus of course program startup initially) by eventually requesting certain operations (like changing the state of the screen) whose exact functioning remains outside the programmer's theoretical arsenal. Application developers have only a vague idea of how values and types in code are marshalled to an from electrical signals physically affecting (or reporting state from) devices like monitors, mouses, and keyboards. This is by design: if you're too closely attuned to low-level cyberphysical details, like how source code function calls map to digital signals, you're no longer doing computer programming (maybe you're doing chip design). To the

degree that programming has a theory, it's a theory of how to *bridge* users' desired interactions with the software you are building *to* the digital structures encoded at the level of microprocessors and machine language. It is not a theory of microprocessors themselves. Theory well-formedness in the realm of programming — the field sonetimes called Software Language Enginering — reflects the transforms bridging "Human Computer Interaction" with machine language; it is not a theory of HCI or of machine languages themselves. Indeed, HCI methodology is subjective and statistical; and the methods of physically realizing machine language in microprocessors depend on physical and nanochemical properties. Well-formed Software Language Enginering theories *have* to leave both HCI and microprocessors out of the frame, since software programming languages are not statistical or subjective, nor physical or nanochemical.

The hierarchical nature of computer architecture complicates any "mind as computer" metaphor: computers have many subsystems, with significantly different structures and properties. Using computers as case-studies of artifacts that are in some sense "intelligent" can take us in different directions for different answers as to what scale of computers' organization we propose to inform, say, cognitive-linguistic research: microprocessors? Machine Language? Programming languages? Software systems? The internet? Many instances of "mind as computer" analogic reasoning are not explicit research paradigms being proposed forth but are more like reports of intuitions: a community of linguists feeling that there's something going on in how computers work that usefully models or resembles how human rasoning or language-processing works. But cashing these intuitions into systematic models can prove challenging: even insofar as a computer may exhibit intelligent behavior, it does so only in an emergent manner, the whole "intelligence" being possible only through specific kinds of interaction between subsystems, in particular a tightly determined transition between high-level systems (like applocation source code) and low-level systems (like machine code).

Of course, many researchers probably believe that this emergent dimension is precisely why computers are a plausible cognitive analogy: they suggest that intelligence can be realized in structural systems whose lowest-level operations are not particularly complex. No-one would argue that in and of itslf a simple Van Numann machine is particularly "intelligent"; but software evincing intlligent bhavior can be implemented as emergent phenomena for which Van Numann machines are their reductive base. This may sem like a useful analogy to consciousness, realized in neurons and synapses even though neurons and synapses are not themselves conscious. That's an acceptable intuition, but it also leads to a kind of philosophical bait-and-switch: what starts as a "mind as computer" intuition ends up as a different kind of analogy, something more like comparing minds to functional systems *implemented* on a computer. There is a difference between being a system realized on a computer and actually being a computer.

In the case of language comprehension, someone may find a useful analogy in database-like constraint-solving applications, like Prolog: language users maintain an internal store of beliefs — about both language and the world — and a record of prior steps in the current conversation. This "database" gets updated as we hear new sentences, and we are equipped to make or reject inferences based on inference rules and constraints, respectively: from "John is my younger step-brother" we can conclude both that the speaker's parents are divorced and that John is not female. Of course, real-world complications sometimes intrude on the kinds of tidy frames linguists build around words: a brother can actually be a transgender woman, and divorcés can remarry each other. We can debate whether these are semantic or pragmatic issues (I think they're the former, but let's say they are the latter for sake of argument). So let's say language has enough logical order that conversations can be modeled rather like Prolog programs. These leads to a maybe-interesting mind-as-Prolog analogy, but — here's the crux — mind-as-Prolog analogies are *not* mind-as-computer analogies. Computers *run* Prolog programs; it's not that they *are* Prolog sessions.

Indeed, I think many "mind-as-computer" analogies are actually more like "mind-as-Prolog" analogies, or substitute some other technology for Prolog. For instance, mind-as-artifical-neural-network analogies are not mind-as-computer analogies, because computers are not ANNs (though they may implement them). Indeed, ANNs are designed to make computers more humanlike: to transcend the mechanistic limitations of Van Neumann architecture by realizing, at some virtual level,

a more connectionist manifestation of computation. A mind-as-ANN analogy is therefore really mind figured as a computer programmed to operate like a mind (so, the analogy is basically circular). Mind-as-symbol-processing analogies have similar issues: computers are not symbol-processors, though they can implement symbol processing systems. As I'll defend below, I think computers are basically stack machines, and stack machines do not "process" symbols — what they do is process stacks, and jump around to different subroutines. When people think about "computers" in mind-as-computer analogies — or write in ways suggestive of such an analogy — I often get the impression that what people are really thinking about is not "computers" but some sort of mathematically formalizable, functionally specified system that can be *realized* on a computer.

These other analogies are not *a priori* bad — it's reassuring if we have accounts of intelligence that traffic through functional organizations that can be realistically embodied in mundane physical artifacts, rather than needing some magical mind-gunk. But if our "mind-as-computer" analogies are nothing more than a desire to find logico-functional systems that can credibly undergird cognitive behavior, computers are basically irrelevant: the computational realizability of such logico-functional systems is a nice reminder that we're not asking non-philosophers to believe in magic, but the structure of these systems are sufficiently remote from how computers internally operate that computer realizability should have no *theoretical* role. In other words, mind-as-computer analogies are usually basically mind-as-logico-functional-system analogies.

We're entitled to find these latter analogies intuitive. My problem is only with mind-as-logico-functional-system analogies that get defended *by appeal to* mind-as-computer analogies. There seems to be a kind of metatheoretical pattern that goes something like this: mind is metaphorically a logico-functional system *because* mind is metaphorically a computer, and logico-functional systems (when not just abstract mathematical territories) are realized via implementation in computer architecture. But mind-as-computer is not logically related to mind-as-logico-functional-system — any apparent link between these analogies is a biproduct of intellectually bakgrounding the distinction between *being* and *implementing*. We may or may not like a mind-as-computer analogy, but even if we *do* accept such a perspective, even if provisionally, this does not then legitimize or entail that we are accepting a mind-as-logico-functional-system analogy. Of course, we can judge the latter analogy on its own merits, but the former analogy in no way retroactively justifies the latter.

So, my strategy for the remaining sections of this paper is as follows: I will review some language-philosophy controveries and argue that disentangling mind-as-logico-functional-system from mind-as-computer analogies should change our estimation of theoretical claims apparently motivated by mind-as-logico-functional-system paradigms. I will then present a different basic account of language processing which, I believe, does not work in any logico-functional-system orientation, though I will recognize some fashion of functional orientation. I will in places appeal to computer architecture, though the framework I propose will only absorb "mind as computer" analogies to a limited, targeted extent. A central theme will be that *logic* is not terribly relevant for either language or computers: functionally-organized systems do not have to be *logico-functional* systems. The ambient philosophy guiding these arguments is that "logic" in any formal, symbolic sense is not the proper vehicle for understanding the structured transitions and causative propagation endemic to multiscale, emergent systems.

Biology, for example, is not a *logical* intermediary between medicine and physics. We can consider how best to describe its "intermediariness": as a theory-construction maxim (in the sense that intermediariness is expressed in which laws/obervables are thematized and which are deferred to other sciences), as a causal network grounded in cross-scale physical constitutions and mereologies (e.g., tissues are both physically composed of cells and are wholes where cells are parts), as an emeregnt system which both *is* (vis-à-vis other sciences) and *has* a reductive base. Sciences are like computer programs in that they have *inputs* (observables from other sciences) and "outputs" (laws from other sciences). I use thse terms because they track analytic trajectories: medical *observables* (e.g. that many people who are exposed to a toxin develop neurological damage) are linked *via biological analysis* to causal/material explanations (how the toxin chemically damages nerve cells). Biology neither statistically models the medical observations nor physically explains the causative mechanism, but it provides a theo-

retical machinery for rigorously modeling and analyzing the transition between them. It writes the second act of the explanatory play, so to speak. Pictured computationaly, the analysis is like a computer program whose inputs are higher-scale observables (saay, medical data) and whose "outputs" are numerical models whose formulae or justifications are solved by other sciences — by analogy to programmers calling system-kernel functions. In this analogy, medicine is like the end-user, biology is the application developer, and physics is the system kernel.

These are analogies informed by computers, of course, but I am trying to focus in on the "intermediariness" they evoke. How computer software bridges users and bare-metal is a useful metaphor for how scientific theories bridge observations and causal/mathematical microphysical models. And, correlatively, how sciences bridge between other sciences — higher sciences yielding obsevrations that are "inputs" to intermediary explanations, lower sciences defining formats for "outputs". Biology, for example, can defer to chemical or physical explanation if it can provide data in structures adequate to chemical or physical formulae: the reference frames, quantitative measures, dimensional systems. Biology does not need to solve such equations, just marshal data into their form. So a good biological analysis will take observation data (e.g. from physics) and transform it to equational data in some sense, wherein chemistry and physics take over. By analogy, correct computer software takes obsevrations (data in computer files and user actions) and translates these observations to the proper system-kernal calls, whrein the Operating System takes over.

Sometimes logical constraints come to bear on these transitions, but the importance of logic per se is overshadowed by the overarching phenomenon of "intermediariness": how the technical and ontological status of computer applications is defined by their intermdiary position between input data/user actions and low-level system calls. Analogously, sciences are characterized by their posits' ontological status as — and their theories' structural criteria regulated by — intermediariness between observational data from one per science and causal/mathematical formula from another. As a philosophical gestalt, such "intermediariness", I believe, should take the place of "logic" in our intuitions.

In the specific contexts of Conceptual-Role and Truth-Thoretic Semantics, I will now show what for me this means in practice.

1 Conceptual Role Semantics and Externalism

Conceptual Role Semantics is often discussed together with a particular internalism/externalism debate which it tends to engender. Here I want to defend a kind of Conceptual Role Semantics (hereafter CRS) but I will first outline an account of compromise between externalism and internalism. I will suggest a compromise different, I believe, than Ned Block's "two factor" model that seems considered the leading example of an externalist/internalist hybrid.

The basic CRS picture is that linguistic meanings should be associatd with conceptual rols in pur understanding situations more than in terms of their reference to external objects. Given sentences like

- (1) He opened the wine bottle with an ornate corkscrew.
- (2) He opened the beer bottle with a butterfly corkscrew.
- (3) He collects antique corkscrews and just bid on one online.
- (4) I thought this was a screw-top but it turns out I need a corkscrew.
- (5) This X3D file shows a very realistic corkscrew created with NURBS surfaces.
- (6) Could you send me the corkscrew (the X3D file you just mentioned)?

we should interpret "corkscrew", first, as a concept in a kind of functional organization. In some of these sentences there is also a specific corkscrew (qua phsyical object) on hand as a referent, but its actual physical properties — or even identity — is not decisive for the meaning of the sentence. After all, in (4) the speaker is not thinking of any corkscrew in particular (probably — more on that later) and in (5) and (6) the corkscrew is not real (at least not real qua corkscrew). But the conceptualization associated with "corkscrew" does not seem markedly different in (1) or (2) versus (4), at least (more on the other three later).

Not only physical details but even lexical identity seems tangential to the important conceptual meanings.

Suppose I am hosting two guests, one has a magnum of ale and one a bottle of Malbec. They ask, respectively:

- (7) Do you have a bottle opener?
- (8) Could you get me a corkscrew?

and I give the first guest a butterfly corkscrew and the second a folding multi-knife. What I gave them is different from their request, but they should think nothing of it insofar as the winged corkscrew has a gap on its handle suitable for beer bottles and the multi-knife has a fold-out corkscrew helix. I have not violated any conversational maxims, because I reasonably assume that the instruments I gave them are suitable for the desired goals, of opening their bottles. Semantically "corkscrew" really means "something that can be used to open a wine bottle", and in that sense the lexeme gets it principle content from this operational role, not some list of attributes (like spiraly and graspable) or prototypes.

Granted, a suitably designed winged corscrew can be construed as a kind of bottle opener, and a multi-knife a kind of corkscrew respectively. We are prepared to accept these tools as examples of the respctive concepts if they are functionally designed to support those tasks, even if they are not the primary function. But our inclination allowing concepts to dilate modulo functional criteria suggest that our grasp of concepts is first and foremost functional-pragmatic: we tend to internalize concepts in reference to (extralinguistic) functional roles and expand concpts to accommodate varigated implementers of those roles.

We can indeed accept sentences like:

- (9) He opened the bottle of beer with a hammer.
- (10) He pounded the nail with a lever corkscrew.

Of course here we are inserting objects into a conceptual nexus where they are not usually found. Winged corkscrews are often *designed* to double as bottle-openers, but lever corkscrews are not designed to double as hammers. Nevertheless we have no trouble imagining the scenarios being described, where someone uses the thick part of a corkscrew to pound a nail, or a hammer's handle-claw gap to pry off a bottle cap. We have schemata for "a tool to open a capped bottle" and "a tool to pound a nail", and the concepts of bottle-opener and hammer occupy that conceptual niche insofar as they are artifacts designed for those purposes. But the conceptual "slot" for, say, "a tool to open a capped bottle" is more general than the specific tools designed for those purposes.

We nonetheless *would* be presumably violating conversational maxims if we handed our friend who wanted to open a beer bottle a hammer. Even if there's a way to make the hammer work for that purpose, it's further outside the norm than, referring back to (2), proposing to use a winged corkscrew. So the implicature in (2) is satisfied, let's say, by bringing my guest a winged corkscrew, but not a hammer. But we can entertain the *thought* of using a hammer as a bottle-opener, and even this possibility presents problems for simplistic thories of language acquistion as essentially learning a static set of word correspondances, like "a hammer is used to pound nails" or "a corkscrew is used to open wine" — after all, you cannot conclude from

- (11) A hammer is somthing used to pound nails, *and*
- (12) A lever corkscrew is something used to open wine, *and*
- (13) A lever corkscrew can be used to pound nails

that a hammer is a kind of lever corkscrew and can therefore open wine. What we *do* have are conceptual slots available encapsulating ideas like "that which can open bottles" or "that which can pound nails", and we "fill" these conceptual slots with different lexical content in different situations. The "that which can open capped bottles" slot can be filled descriptively — i.e., in declarative speech, like in (9) — by a hammer, but not in other kinds of speech acts (we cannot read the concept "bottle opener" as satisfied by "hammer" in the context of a request for a bottle opner). Note that the scope of conceptual roles can change merely by switching between locutionary modalities.

The takeaway from this discussion in the internalism/externalism setting is that conceptual roles have a linguistic priority over and against both lexical and physical realizers, and the scope for things inside and outside of language to play (or not play) such roles varies with context. I have introduced these issues via tool artifacts (like corkscrews) but would be closer to the spirit of the CRS internalism/externalism debate by discussing natural-kind concepts. Suppose I am building a sand castle on a beach and ask someone one of:

- (14) Can you bring me a bucket of water?

- (15) Can you bring me a glass of water?

For (14), a reasonable reaction would be a bucket filld with ocean water; but for (15) my addressee would probably infer that I was thirsty, and — since salt ater is non-potable — was requesting water I could drink. But "*glass of* water" probably figures here just to establish my intention to drink it: you are entitled to bring me bottle of water instead. In other words, my request has implied content which in some aspects loosens and in some aspects restricts the conceptual scope of semantic entries in my utterance. Thus oceans are composed of water, and near a beach I can say:

- (16) The ocean is over there.
- (17) The water is over there.
- (18) You can see the ocean from here.
- (19) You can see the water from here.

Each pair is almost identical. But ocean-water ceases to fall under the conceptual role of "water" when we are in the context of drinking things instead of the context of geography. This suggests that water does not "mean" H_2O or other saline or non-saline water: the meaning is not fixed to any particular chmical composition but adapts to the situational context, including what the water is used for — e.g. as a drink or as a binder for a sand castle.

The most-discussed "water" analysis in the literature is less earthly than this: Putnam's "twin earth" argument about a planet whose substance (with chemical makeup) XYZ functionally indisinguishable from our (H_2O) water. Externalists and internalists use this thought-experiment to express their differences as disagreements over whther twin-earthers' XYZ concept is the same as our H_2O concept. For the latter, as the basic account goes, XYZ plays the same conceptual role in their lifeworld as H_2O plays in ours, so it is the same concept; for the former, the concepts designate different material substances (even if twin-earthers don't know this) so they can't mean the same thing, even if there is some sort of analogy or resemblance between them (concepts can be analogous or similar while still being different concepts).

Before making a case for one alternative here over the other, let me note the following: it is unfortunate that the case-study is formulated in terms of XYZ vs. H_2O, because at the level of molecular composition it is hard for us to conceive that XYZ is *really* indistinguishable from water. After all, our concptual understanding of water includes things like electrolysis — if XYZ does not emit hydrogn and oxygen when electricallly charged under certain controlled conditions, it is not behaving like water and can not be (even internalistically) construed as conforming to our concpt of water. Of course, we are free to expand our water-concept, just as we contract it when switching from geology/geography to drinking. But here we expand it with full recognition that finer-grained concptual distinctions are possible, just that there are many contexts where they are unnecessary.

We do not need to contemplate far-fetched twin-earth scenarios to see this in practice: here on earth we have deuterium water which is chemically different from normal water (but both have the H_2O signature, although heavy water is also described as D_2O). We are free to let "X" mean normal hydrogen, "Y" mean deuterium ions, and "Z" mean oxygn, so XYZ becomes what chemists call HDO — semi-heavy water. Most people would probably say that HDO is just a kind of water, and so can be subsumed under the concept "water", but this is not conclusive. In reality, I don't think the English community has needed to establish whether "water" should mean ordinary H_2O or should include variations containing different hydrogen isotopes — whether heavy and semi-heavy and other variants of water should be considered "water" or some other concepts.

In practice, a fraction of ocean water has deuterium, which might argue for "water" subsuming heavy water — we don't point to the ocean and say

- (20) The water and the Deuterium Dioxide is over there.

But this can alternatively be explained by the principle that referring to an impure sample of a substance is still a valid use of the concept:

- (21) Here's a glass of water (even though tap water is mixed with flouride).
- (22) Bing cherries are dark red (even though the stem is brown).

In the second case, we can validly call something red even if something less than its whole surface shows a red color. Applying a similar rule, we can call a solution "water" if there are only "sufficintly small" amounts of solutes.

Clearly we use "water" to dsignate many substances other than pure H_2O. I can think of two options for explaining that semantically: (1) Salt water, tap water, distilled water, (semi) heavy water, etc., are all different kinds of water, but our coarser "water" concept subsumes them all (in most contexts). (2) There is only one water concept, pure H_2O, but impure samples of liquid that are mostly water can be called "water" by the same principle that a mostly red-colored object can be called just "red".

The second option has a common-sensical appeal because it fits a succinct "concepts as natural kinds" paradigm but does not venture too far from normal language use — that "red" actually means "mostly red" is a pattern common with many nouns and adjectives (someone can be *bald* with a bit of hair; I can point to a turkey burger made with bread crumbs and spices and say "that's turkey"; I can tell someone listening to Keny Arkana's song "Indignados" "that's French", although some of the lyrics are Spanish). However, the "mostly water" reading has a couple of problems: first, what about cases like a "glass of water" where "mostly water" is not "mostly" enough to drink? And, second, why can't we refer to plasma, say — which is 92% water — as water? This is not just a matter of numbers: the dead sea water is much less pure than plasma in the hospital (in terms of percentage H_2O in solution) yet we are authorized to call the former "water" but not the latter. This certainly seems to be a matter of conceptual roles — plasma occupies a certain place in our conceptual systems about blood and medicine (largely because it plays a specific role in biology and medicine) which does not fit the profike of "water", while the stuff in lakes *does* fit that profile, even if the lakes are hypersaline. Blood fits a conceptual ecosystem where we are not tempted to subsume it uner the concept *water*, whereas our conceptualization of lakes pulls in the opposite direction — even though by purity the water in Gaet'ale Pond in Ethiopia is apparently not much more watery than blood. Our disposition to either contract or dilate the sense "water" seems to be determined by context — by the conceptual role water plays in different context — rather than by actual hydrological properties.

What about the hypothetical twin-earth XYZ that Putnam imagines is indistinguishable from our H_2O? Well, for this hypoyhsis to even make sense we have to assume that XYZ is scientifically indistinguishable from water, which is a matter not just of pure H_2O but of all solutions and deuterium- or triterium-related variants of water, and so forth. As a thought experiment, where we are free to conceive almost anything, this is not impossible. Let's imagine that there is an undiscovered subatomic particle that on some planets clings to atomic nuclei without affecting them in almost any way. We can call nuclei harboring these particles "twin nuclei", so hydrogen becomes "twin hydrogen", oxygen becomes "twin oxygn", and presumably water becomes "twin water". This twin water would essentilly retrace the the compositional structure of water — since it would have to form (and unform, under electrolysis) just like "our" water. If we plug this "twin water" into Putnam's scnario, I can't see why we don't just call this a variant kind of water, water with some extra (but observationally negligible) particles, just like heavy water is water with extra neutrons.

This does not do perfect justice to "twin earth" discussions, because I am describing "twin" water as something whose composition is almost identical to "our" water. In the original story, "twater" is XYZ, which as written suggests something whose physical constituents are much different than water, even if all propensities that influence our "water" conceptualizations are exactly the same as our water. But something compositionally different than water *can't* be functionally identical to water, at least if any of the actions we can take that reveal water's composition come out different. In short, whatever XYZ are, they must have a capability to *become* hydrogen and oxygen, because XYZ's emulating water means it emits hydrogen and oxygen under electrolysis. Meanwhile there is no action that could "release" the "X" (or whatever) because that would also behaviorally differ from water. So XYZ would differ from water only insofar as in its "unobserved" states it can float around as something without hydrogen or oxygen but, whenever subject to actions that cause water proper to emit these gasses, it would somehow conjure them up in exactly the same patterns as water (which actually *is* composed of hydrogen and oxygen) does.

By dictum, then, XYZ is not actually composed of hydrogen and oxygen, but whatever it *is* composed of can act as *as if* it *does* contain these gasses so as to emit them. In that case I'd question the argumentative

force of claiming that XYZ does not contain hydrogen and oxygen to begin with. We are asked to believe that XYZ is made up of some ethereal non-hydrogen and non-oxygen that can nevertheless become hydrogen and oxygen whenever it is in the physical states wherein water that *is* made of hydrogen and oxygen will release them. I am inclined to say that this is just another way of being made of hydrogen and oxygen. After all, atoms are not little ping-pong balls: what we picture as a water molecule is actually apparently much more ethereal, suspended in quantum indeterminacy. I take it there is some Shrodinger equation for a water molecule, and only when the "wave function" collapses — say, by our observing the water subject to electrolysis — do we actually get hydrogen or oxygen atoms. So "our" water isn't really "composed" of hydrogen or oxygen in its pure quantum state. Maybe XYZ "collapses" to hydrogen or oxygen in different ways than earthly water (but with no way to measure the difference), but this is still not divergent enough that for me to feel compelled to call XYZ anything other than some variant form of water.

Of course, I am assuming that twin earthers have *the same* water-concept that we do, *in all respects*. Maybe a more faithful review would consider that twin earthers might have a related but more primitive water-concept than ours — maybe some subset of our concept in terms of the scientific knowledge embedded in our concept. Before we earthers knew about hydrogen, oxygen, or electrolysis, the behavior of water under electrolysis was not a factor in our concept of water. So imagine if twin earthers' level of scientific knowledge was akin to that on earth centuries ago — their XYZ is measurably different from our water, but they have no experimental our scientific apparatus to notice the difference. But this is *contingent*: the twin earthers *could* some day discover hydrogen and oxygen. Then, if XYZ really is not composed of hydrogen and oxygen (or acts as if composed of them when not in a nonobservable ethereal state) their scientific theory of water, and accordingly their conceptualization, would diverge from ours.

We can imagine a non-water XYZ that is water-like enough to play an identical rooe to (our) water, but this story can go in two directions: either XYZ is *absolutely* identical to water, its differences from water so obscure as to be observationally and causally maningless; or it has legitimate differences from water that *could* be conceptually significant but in some context are not (at least not yet). These are two different thought experiments. If some substance is in alll respects and under any conceivable science identical to water, yet somehow compositionally different from it, I think the plausible respone among normal language communities would be to extend the concept of water — subsuming XYZ under the concept, analogous to heavy water when it was discovered. We are generally prepared to expand the reach of concepts when there is no compelling reason not to do so. Whether a potential expansion takes hold probably varies by context. We are — a point that generally fits on the externalist side of the ledger — more willing to accept expansion when the revised conceptualization would not deviate too far from a basic alignment of natural kind concepts to scientifically reasonable classifications. We can readily extend "water" to D_2O because the two substances are compositionally very similar. We are less likely to accept conceptual mergers when they seem to violate our natural-kind pictures, even if they are functionally plausible: we do not accept "agave" as a subconcept of "honey", even though the two are physically rather similar and functionally very similar. Nor does physical form alone drive conceptual boundaries: we know full well that water vapor and ice are the same stuff as liquid water, but we recognize a conceptual distinction between them.

But these are not hard and fast rules: we may be inclined in many contexts to treat frozen-concntate juice as conceptually subsumed under "juice" (as in "juice on sale"), and we will often accept almond milk or cashew milk as "milk", despite physical differences which we certainly acknowledge. In short, concptual boundaries tend to be drawn to honor, albeit without excess granularity, both physical and functional factors — neither physical/compositional similitude alone, in the absent of functionalv resemblance (see water/ice) tends to earn concept dilation, nor vice-versa, but a mixture of functional and physical similarity even with *some* differences in both aspects tend to be likelier drivers of concept-expansion (see water vs. chlorinated water, or red wine vs. white wine). By these rules, expanding "water" to include XYZ — if XYZ is functionaly identical to *but* compositionally different from water — would be abnormal, like expanding "milk" to — without any qualification — include almond milk. But these rules are approximate, and on the idiosyncratic case where XYZ

is *completely* functionally like water but (stipulated to be) physically different (though by functional identity we could not detect as much), I think the normal "conceptual dilation" rules would side with the functional identity and ignore the physical differences.

On the other hand, if XYZ has real discoverable differences from water, then the potential exists for twin earthers' concept of water to divrge from our own, even if at any point in time the concepts are identical. The time "points" don't need to be simultaneous: we can compare one country's concept of water in the year 1800 with a diferent county's in the 16th century. It is plausible that different people at different times have effectively the same conceptual attitudes toward concepts that, with the benefit of hindsight and more science, we know have potential for differentiation. I think the mere potential for differentiation warrants our identifying conceptual differences even if the parties involved are not aware of this potential. I am prepared, for example, to accept that a child's water-concept in our time can be different from a medieval child's water-concept merely by virtue of the modern child potentially learning about deuterium, hypersalinity, and other scientific nuances that complicate the modern conception of water relative to our forebearers.

We certainly accept that people may have different understandings of a concept and, on that basis, may judge that what two people are entertaining are two different concepts — though we may also feel that they entertain two variations of *the same* concepts. There's room for most concepts to "diversify", subsuming subconcepts and variations; hence there's roon for a concept to expand (see water to heavy water) without fragmenting. But sometims we *do* insist on splitting concepts — or, eqivalently, refuse to accept a concept-enlargement — and *the reasons for this refusal may be external to some peoples' use of the concepts.* Current political discourse in the United Stats, for example, is driven by turns of phrase that are rather haphazardly defined: "Climate Change", "Border Wall", "Green New Deal", "Free Tuition", etc. Suppose a health policy expert observes that Bernie Sanders's use of the term "Medicare for All" is different from Kamala Harris's. She may conclude that Sanders's concept "Medicare for All" is different from Harris's concept — and the rationale for this conclusion ned not take into account whether the two candidates are aware of the differences. Suppose, as an expert, she has to mentally track the differences — she has a well-informed judgment that each of the "Medicare for All" plans have different ramifications due to policy differences; as a result when discussing "Medicare for All" she needs to note in her own mind which version of that idea is under discussion at any moment in a discourse. That is to say, she needs to subsume them under different concepts. Moreover, we endorse that she *should* do so, even if she thereby makes a distinction that the politicans or their supporters themselves do not realize. In this kind of case we may defer to expert opinion when adjudicating a potential conceptual divorce, even if there is only minimal differences in the role of the concepts vis-à-vis the conceptual systems of many relevant parties.

The possibility that "Medicare for All" may play the same *role* in a Sanders supporter's and a Harris supporter's conceptualizations does not preclude our judging that they are nonetheless different concepts — if by virtue of more information and more access to expert counsel we can understand that there are potential differences in their conceptualizations that *could* drive the conceptual roles to diverge. I think this is analogous to a "twin earth XYZ" scenario in that the thought experiment is set up as if we have access to expert confirmation that twin earth's XYZ is not physically the same substance as water. Projecting from earthly practice, we accordingly accept that "externalist" considerations may need to come to bear, and "XYZ" may need to be classifid as a different concept that water *notwithstanding* the lack of any concptual role difference between XYZ for twin earthers as compared to water for us. This is consistent with our tolerance for including factors beyond just concptual roles in more mundane circumstances: we accept that sufficiently divergent notions of "Medicare for All" *could* be most appropriately classified as two different concepts. Such is not mandated — we could certainly describe the Sanders and Harris platform as "two different Medicare for All plans", subsuming them under one concept but acknowldging their differences — as token differences, like the conceptual difference between this apple and that apple, rather than concept-differencs like apple vs. cherry. Analogously, we *could* subsume XYZ under the concept *water* — XYZ being a kind of water insofar as samples of XYZ (tokens of the XYZ-concept) bear some physical differences to tokens of ordinary water (like heavy-water samples do), but we can handle this

variation on a token-token level (analogous to comparing two apples). But we can *also* split rather than expand the conceps — *divorce* rather than *dilate* — making XYZ a different concept than water, just as we can make Sanders supporters' Medicare for All a different concept that Harris supporters. The key point is that our choice of "divorce or dilate" may be driven by factors wholly external to some concept-bearers' internal concept-uses. Two different concepts — recognized by us as different — may play identical conceptual roles for some people.

This stance is at least minimally Externalist in that I don't insist on internal conceptual-role similitude being an immovable criteria selecting "dilate" over "divorce". We as a language community can and sometimes should override the tendency for concepts to expand under role considerations. As I pointed out earlier, a corkscrew and even a hammer can sometimes satisfy the role "bottle opener" in specific contexts. Usually we distinguish context-specific concptual role-playing from general concept dilation — I think this is the gist of Zhaohui Luo's analysis of "situations" and "Manifest entries". We can adopt a temporary frame of reference wherein, say, hammers are bottle openers — or in Luo's example (in a single zoo exhibit) all animals are snakes — without mutating the concepts so wildly that "hammers" become expanded to including anything that may open a capped bottle, or "snakes" become all animals. Yet such situational dilations can recur and eventually spill beyond their situational guard rails. In a vegan cafe I can imagine the staff converging on a usage that soy, almond, and cashew milks are collectively called just "milk". If veganism becomes entrenched in some English-speaking community I can similarly imagine that in their dialect "milk" will mean anything that can be used like milk in a culinary context. The warrants for such expansions sem to be drivn by concptual roles — situations present "slots", like *that which opens this bottle* or *that which I pour on cereal*, and existing concepts tend to expand to fit these slots.

These considerations follow the *internalist* line: we take attitudes based on conceptual role more than external natural-kinds when adjudicating conceptual boundaries. Thus situationally we may present almond milk and agave to satisfy a request for milk and honey. But superimposed on "centrigual" tendency for concepts to expand into "under-lexified" concptual niches we have a counter tendency to question conceptual uses where functional resemblance strays *too far* from common sense. Someone may accept agave in lieu of honey, or a hammer as a bottle opener, in the context of how one situation plays out; but they are less likly to accept these uses becoming entrenched, compared to, say, refiguring "milk" to include almond and cashew milk. And our hesitation to accept concept-expansion in these latter kinds of cases seems to implicitly look beyond concptual roles — we may insist on limiting concept dilations even if there are many people for whom there will never be situations where the differences between concept referents, over and above functional resemblance, would be important. In short, even if a community could do just fine with some dialect idiosyncracy that ignores a conceptual distinction we would ordinarily make, we don't tend to take this as evidence that our multiple concepts can be merged into one more diverse concept.

Of course we *can* merge concepts, and the fact that many people can live their lives without a conceptual coarsening may render such merger likelier, but it seems we evaluate potential mergers more by reference to entire speech-communities, not isolated parts. Note that I am speifically talking here about merging or splitting concepts, not word-senses or lexemes or any purely linguistic artifacts. Certainly we have variegated "water" concepts — salt, tap, distilled, heavy — but we have an overarching water concept that includes these as subconcepts. We can make a conscious decision to modify concept/subconcept relations — which is different from changing how concepts are mappped to lexemes. So I take it that Conceptual Role Semantics prioritizes role factors in drawing concept/subconcept relations and boundaries, and the consequence is a mostly Internalist intuitive model: we should accept concept maps where concepts are mostly drawn together when there is a functional resemblance between their roles: our concept/subconcept renderings should witness and help us exploit functional analogies.

At the same time, however, I think we instinctively project notions of conceptual role outward from individual perople or subcommunities to the social totality. Even if technically distinct Medicare for All plans play similar conceptual roles in different voters' conceptions, we understand that such similarity may break down as we expand the community outward. Sanders and Haris

supporters don't live on thier own islands. There are factors outside their own minds that weigh on whether their functionally similar Medicare for All concepts are indeed *the same concept* from the larger communiy's point of view. But these external factors are not necessarily *extramental*: we can zoom outside the concptual patterns of one subcommunity and argue that concptual differences appear in the overall speech community that supercede functional resemblance in some subcommunity. Conceptual roles are not solipsistic: the role of the concept Medicare for All for a Sandrs supporter is not just a role in *his* mind, but it bcomes a role in *our* minds if we dialogically interact with him.

Insofar as people can make inferences about other peoples' conceptual role "system" — we can figure out the role which a concept plays in somone else's mind, to some approximation, even if analogous concepts play a different role in our own minds — conceptual roles are not private affairs; the have some public manifestation and there is a need for collective reconciliation of role differences, just as we need to identify when different people are using the same words in different ways and use lexical conventions to diminish the chance of confusion. To the extent that they have this public dimension, conceptual roles are not *internal*. But "externalism" in this sense is waranted because we want to look philosophically at entire speech or cognitive communities — it is not automatically a philosophy of conceptual content being external to "mind in general". Conceptual differences that could *potentially* become publicly observable from the vantage point of the *entire* cognitive community warrant consideration for conceptual divorce over dilation — overriding similar roles in some *part* of the community.

In the case of XYZ, insofar as the twin earth cognitive community and our own could *potentially* become part of a single overarching cognitive community, we have potential grounds for drawing comparisons between water and XYZ. Merely by contemplating their planet here on earth we are performatively drawing twin earthers into our cognitive community. By postulating that twin earthers think about XYZ the same way we think about water — and that we know this — we implicitly assume that their conceptual role patterns are public observables in the context of our own community. If conceptual roles are observable, then there is a concept of a conceptual role: pundits can conceptually analyze how "Medicare for All" plays identical conceptual roles for Sanders and Harris supporters even if the candidates' plans are consequentially different. But this merely says that there are latent differences in two people's conceptual roles that they themselves may not actually experience. The public facet of conceptual roles complicates the notion of conceptual role similarity — two persons' patterns of conceptual rols may be observably different as public phenoemena even if the people lack resources to realize the difference. Conceptual roles are therefore external to individual minds — but this is by scoping outside individual minds to holistic cognitive communities who can publicly observe our cognitive tendencies. We are still reasoning "internalistically" in the sense of considering cognitive patterns at the scale of an overall cognitive community.

In short, I will take the mantra of an "Externalist" when passing from individual minds and subcommunities to the public nature of conceptual roles and overaching cognitive communities. Once we get to the maximal possible community, however, I am inclined to revert to Internalism: if there is no broadening of communal scope that could make putative external diffrences meaningful to *anyone's* concptual roles, I see no reason to account for *these* erstwhile externalities in a theory of concepts. If XYZ has *some* not-water-like qualities that a sufficiently large cognitive community could confront — even if XYZ-conceptual-role and earthly-water-concptual-role is identical for the two isolated communities — I am happy to accept that twin earthers' XYZ-concept is a different concept than earthers' water-concept. Similarly, I accept that Sanders supporters' Medicare for All concept may be a different concept than Harris supporters'. But in both cases I accept concept splitting to ovrride role-similarity because I believe in an overarching cognitive community which has an interest in detecting differences or potential differences in conceptual roles qua public obsrvables, which transcendes our own internal awareness of what our conceptual roles entail. The fact that earthers and twin-earthers might never "discover" a water/XYZ difference is a contingent fact, not an essential structure in policing conceptual maps. When establishing how we should consider redrawing thse maps, we should work from the picture of an overarching comunity that can subsume isolated communities as an abstract posit; the parts of the twin earth story that imply earthers and

twin earthers could never actually discover their differences are not, I think, compelling as intrinsic features of the analysis. In short, if water and XYZ have some potentially observable differences, then we need to proceed as the community which is aware that these differences exist and that therefore, for us, water and XYZ need different conceptual slots. The only analysis then is how to reconcile the fact that we have multiple conceptual slots whereas twin earthers (and earthers who have not read Hillary Putnam) have just one.

But if we take a *maximal* cognitive community — the sum total of earthers and twin earthers and philosophers — this community *does* distinguish XYZ from water (surrely XYZ plays a different role in Putnam's mind than water). And we should scope to the maximal community when determining whether smaller communities' conceptual roles are truly identical, because conceptual roles are, in part, potential public obervables for any possible supercommunity.

On the other hand, if XYZ is so much like water that *no* community would *ever* have reason to contrast twin-earthers's XYZ-conceptual-role with our water-concptual-role, then I think these roles are not just *internally* identical for each (twin-) earther, but *publicly* identical for any conceivable cognitive community for whom public observations of (twin-) earthers' conceptualizations are consequential givens. And in *that* case I think XYZ is the same concept as water notwithstanding putative compositional differences.

The whole idea that conceptual roles can be *public* complicates the Internalist/Externalist distinction, because each person's conceptual patterns can be evaluated from a vantage point external to *their* mind but still within the proclivities of a "maximal" cognitive community. Concptual roles are not private to each person, but are private inclinations that get reshaped, corrected, influenced, or reinterpreted by a larger community. If we understand conceptual roles to include the totality not just of each person's conceptual role attitudes but the totality of how these attituds are observed by others, then we should consider that concepts are not "external" to the *maximal* cognitive comunity. Externalism about *individual* minds can be wrapped inside Internalism at the *maximal* inter-cognitive level.

But, complicating matters further, the maximal community's observations of conceptual-role attitudes is often driven by at least our *belifs* about external (i.e., extramental, natural-kind) criteria. For example, some companies want to rechristen "corn syrup" as "corn sugar", to make it seem more like a sugar-subconcept. Meanwhile, some dairy companis want laws restricting the use of "milk" for vegan products. In both cases our larger community has a chance to weigh the proper conventions for how our conceptual maps should be drawn. As I argued earlier, both functional and naturalistic criteria play a role in such deliberations. We are poised to distinguish transient situation-specific roles — that one time someone used a hammer as a bottle opener — from functional parallels that stretch across many contexts. Within the parameters of that contrast, we are receptive to redrawing maps on role criteria — allowing milk to subsume vegan milk-substitutes, for instance. But this tendency is balanced by a respect for some notion of coherent natural kinds — the distinct biological properties of vegan milks work against a *maximal* community subsuming them under "milk" outside of special contexts.

Both the Externalist and Internalist points of view have some traffic in the considerations that cognitive communities bring to bear on which concptual maps should be enorsed by convention. Because ad-hoc conceptual roles can be established for particular situations, we can be conservative about *conventionalizing* concept maps driven by functional correspondancs too far removed from (what we think to be) scintifically endorsed, natural-kind boundaries. In other words, I think we *do* and *should* allow "naturalistic" considerations to be a factor in what concept maps we endorse. But this is not a claim about Externalism as a philosophical paradigm shaping how we should construe the triangulation between mind, world, and language, as a matter of metaphysical ideology. Rather I believe that "externalist" factors should and do come to bear on the deliberations *internal* to cognitive communities' (sometimes but not always explicit) evaluations of how to draw concept and subconcept boundaries and relations — when to split concepts and when to dilate them. Dilate-or-divorce options are are pulled by both externalist and internalist considerations, sometimes in competing ways.

As as case-study, the wording "corn sugar" — which implies a "redistricting" wherein the concept "corn syrup"

becomes part of the territory "sugar" — may be credible on purly biochemical grounds. But our community may feel that there is enough functional difference between sugar and corn syrup from a commercial and nutritional sense to reject a proposed merger — here functional considerations trump natural-kind ones. Conversely, the community may be sympathetic to claims that milk substitutes should be labeled to clearly indicate how they are are not *literally* milk — here natural-kind considerations trump functional ones.

If we consider language — and communally-endorsed conceptualizations — evolving in practice, then by light of my claims until here there is material for both Externalist and Internalist readings. This perhaps leaves room for a theory which accepts that both are partially true — each being logically founded under consideration of two different aspects of how concepts evolve. I will explore this possibility further, but first I want to shore up my account of conceptual roles themselves. One complication I have glossed so far is that *functional* roles in an enactive and "pragmatic" (in the everyday-world sense) spheres are not *ipso facto* the same as either conceptualizations (conceptual-role-attitudes) or lexicosemantic conventions. Thse three are interrelated, but we need social and cognitive practices to get situational understandings entrenched in language and in communal concept-maps. Without a theory of this process, to speak of functional roles like *hammer* for *bottle opener* is not a substitute for speaking of conceptual roles *per se*. How to properly link "functionality" in an enactive quotidian sense — the data that various narural and man-made artifacts are used by people for cocrete tasks, and we often talk about this — to the cognitive realm of concepts (and their boundaries and subconcept relations)? This is the main theme of my next section.

2 Truth-Theoretic Semantics and Enaction

Corrolary to the idea that roles often determine concepts, is the recognition that we tend to logically evaluate situations in functional terms, through the lens of what we (or any of our peers) are *doing*. Suppose my friend says this, before and after:

- (23) Can you put some almond milk in my coffee?
- (24) Is there milk in this coffee?

Between (23) and (24) I do put almond milk in his coffee and affirm "yes" to (24). I feel it proper to read (24)'s "milk" as really meaning "almond milk", in light of (23). 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) (24) would usually be interprted. In this current dialog, the *milk* concept not only includes vegan milks, apparently, but *excludes* actual milk.

It seems as if when we are dealing with illocutionary force we are obliqued to subject what we hear to extra interprtation, 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 me to close the kitchen window. Each of these are plausible and basically polite responses:

- (25) It's not open, but there's still some cold air coming through the cracks.
- (26) It's not open, but I closed the window in the bedroom.
- (27) 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. Many linguists 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 pople 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:

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

These *can* be read as bare directives, and would be interprted as such if the hearer believed the speaker already knew that yes, he has almond milk, and yes, he gets MsNBC. In (30), if both parties know there's one corkscrew in the house, the statement implies a directive to fetch *that* corkscrew. Or, (28)-(30) 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. But also, (28)-(30) can *also* be read as a mixture of the two, as if people expressed themselves like this:

- (31) I think the window is open, can you close it?
- (32) I see you have almond milk, can I have some?
- (33) If you get MsNBC, can you turn on Rachel Maddow?
- (34) 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 whre 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" quesions 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 that" as an implicature analogous to interrogatives:

- (35) I believe you have a reservation for Jones?
- (36) I believe this is the customer service desk?
- (37) I believe we ordered a second basket of garlic bread?
- (38) I believe you can help me find computer acessories 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 coopratively, 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:

- (39) Do you have any milk?
- (40) Yes, we have almond milk.
- (41) 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". As Luo points out in [], particular concept-maps are admissible as in force in specific situations even if they deviate noticably from typical usage (Luo does not talk about concept "maps" but about subtyping and various inter-type relations, yielding a type-theory of situations I think is relevant to Conceptual Role theories of situations). In any case, 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.

If a diner asks for milk in a vegan restaurant, a waiter may plausbily infer that the customer believes the restaurant *only has* vegan milk, so there is no ned to make that explicit; and/or she assumes that everyone in the restaurant will hear "milk" as "vegan milk". In other words, the waiter infers that "vegan milk" for her plays the same role as "milk" for a non-vegan. This inference is not produced by any speech-act subtleties: a related inference would be involved in

- (42) Is there milk in this coffee?
- (43) Yes, almond milk.

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-faoth effort to cooperate with the pragmatic intent of the spech-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*-cooprative.

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 proposional 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 requsts 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 grand kids 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., thay 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:

- (44) I believe the kitchen window is open — please close it!
- (45) 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 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 itslf, in its totality, a specific propositional content, thinking to purselves (or even saying to others) things like

- (46) Grandma wants us to close the window.
- (47) He wants a bottle opener.

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

- (48) Grandma wants us to eliminate the cold draft.
- (49) He wants something to open that bottle.

We have to read outside the literal unterpretation of what they are saying. This re-reading is something that may be appropriate to do with respect to other forms of speech also: sometimes the true gist of what someone wants to communicate is not stated directly:

- (50) I think you could do excellent work in this class, and I think you are doing pretty well.
- (51) I am not going to talk about the refs because I don't want to get fined.
- (52) If she wants to win the nomination she needs to be as charismatic on the campaign trail as she was during the debate.

But our conversational responsibilty to infer some unstated content is especially pronounced when we are rsponding to an explicit request for something.

Certainly, in any case, 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 spculate 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 (53) from a vegan restaurant, or *kitchen window* to *bedroom window* in (54) if it is the latter that is open:

- (53) Can I have some milk?
- (54) Can you close the kitchen window?

The point of thse "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 (53) and (54): 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 (53) and (54) truth-theoreticaly 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.

Simultaneous with propositional content, of course, are attitudes: the difference between asserting and wanting that the window is closed. It is hard to deny that *some* propositional content is involved with each linguistic expression, because simply by being a structured mental activity the effort to formulate sentences must be extended with some purpose. We say (and write) things to help make something or other the case. But there are several challenges to disentangle the role that propositional content actually plays in meaning. One problem I just considered is that the right propositional content does not always come from *literal* meaning: the vegan *doesn't* want real milk in her coffee. The idea of "mapping" is one way to address this: in place of "literal" meaning we can substitute meanings undr "coordinate" transforms, where concepts transition from their literal designation to their roles. The vegan wants the product that plays the *conceptual role* of "milk" in her own frame of reference (at least in the context of, say, dining, as opposed to a context like checking whether her Staffy is lactating). But there are two other concerns we should have about propositional content, which I will discuss to close out this section.

2.1 *The Problem of Opaque Truth Conditions*

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 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:

- (55) If the kitchen window is closed, we can see if other windows are open.
- (56) If no windows are open, we can see if there is a draft through the window-cracks.
- (57) 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.

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. That is practical, domain-specific knowledge about windows, air, weather, and houses. But 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. But once we converge on the "language initiates a process" model, we can find examples where the logical scaffolding gets more tenuous. Consider:

- (58) My colleague Ms. O'Shea would like to interview Mr. Jones, who's an old friend of mine. Can he take this call?
- (59) 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: (59) could mean that Mr. Jones is not in the office, or in a meeting, or unwilling to talk, or even missing (like the ex-governer consummating an affair in Argentina while his aides thought he was hiking in Virginia). Or:

- (60) Mr. Jones, were you present at a meeting where the governer promised your employer a contract in exchange for campaign contributions?
- (61) 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:

- (62) Is Jones there?
- (63) He is not available.

The speaker of (63) 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): (63) responds to the implicature in (62) that what the first speaker really wants is (for instance) 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 (63) to be (at least) linguistically cooperative while nonetheless avoiding a response at the *logical* level to (62). (63) 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. 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 (63) does seem to evoke some disjunctive predicate. But such does not mean that this disjunctive predicate is the *meaning* of (63). It does not seem as if (63) 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 seing 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 maked 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 logicical 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 contenet 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 logicality 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.

This pattern of logical evasiveness might seem to be endemic only to slippery human language, but analogous examples can be found even in the strict milieu of computer programming. Computer programming involves passing instructions around, and that any one segment of code is typically dealing with incomplete information, like the bodyguard who does not know *why* Jones is unavailable. Given such partiality, it is misleading to assume that *instruction networks* are conduits for logical content pe se. My first rsponsibility as a programmer, at any point in code, is to call the right functions, depending on types, ranges, values, and any contingent environmental factors relevant to what the local code needs to do. Therefore, insofar as several functions might be candidates to call at any one code-location — there are scenarios where one function should be called, and others where a different one, etc. — I have to ensure the correct one is called in each scenario. But, as I will argue, the structures determining how this multiplicity is resolved are not logical structures. They have formal (e.g., type theortic) aspects, but these are not the *kinds* of formal aspects that simply manifest a logical systm.

As a quick example, while implementing a function that compares two lists, I may need to call different secondary functions in different cases like "which list is longer?" or "is either list empty?". There are various program-flow or type-theoretic models to rigorously describe this kind of branching as a computational phenomenon. But these are not logical models, in the sense that they can be fully specified in formal terms without explicit appeals to formal logic machinery (substitution axioms and so forth). In short, *structured systems of instruction-passing* are not *metaphysically* speaking logics — even if one can actually give them a logical model, which then becomes a *reductive analysis* (like Chemistry providing reductive analyses for Biology, which does not thereby *metaphysically* become Chemistry).

Analogously, imagine the bodyguard and secretary as both part of a conversational network which circulates the visitors' request to see Jones, and eventually the response that Jones is unavailable (which implies a counter-request that the visitors leave). Perhaps neither bodyguard nor secretary know all details about Jones's location; but they can still route messages as part of the overall cycle where we ask to see Jones and they ask us to leave. If this "message-passing cycle" is, in its most endemic analysis (outside of any retraoctive reductionism), *not* a logical system — but is rather some other kind of structured system — then the (properly non-reductive) semantics is a "message-passing semantics" or "instruction-network semantics" rather than a "truth-theoretic semantics" — *even if* these models *do* have a reductive analysis to some logical axiomatics. The analogy is again that Biology is not a Chemistry *even if* Biological models have a reductive analysis as chemical models.

Suppose I am writing a function which counts the number of non-blank, non-comment lines in a file. My implementation might start like this (in pseudo-code):

- (64) File f = File.open(path, File.READ_ONLY);
- (65) if f.isEmpty() return 0;

So the first line tries to open a file with the specified path, and the second line checks if the file is indeed open and non-empty. If not, it returns the number zero, meaning that there are no non-blank non-comment lines in the file.

In a typical application framework a file will be opened if it exists and if the current user has permission to read and/or write to/from the file (here the necessary permission is read-only). For sake of presentation I assume that a file is considered non-empty only if it is open and has some content (i.e., you can read something from the file). So if the file *is* empty, that can mean several things: either it does not exist; or it cannot be opened because of inadequate permissions; or it *can* be opened but has no content. My function is noncommital and returns zero in each of these cases. In particular, I gloss over some information: the zero return value is analogous to Mr. Jones being "unavailable" for an interview.

On this basis, it seems as if the "meaning" of my call to open the file is not a matter of ascertaining or bringing about certain truth conditions. It is true that my instruction may bring about certain truths (specifically, make it true that the file is open). But we should not conclude that this potential state of affairs is what the instruction *means*. As the programmer, I do not "want" the file to be opened; I have no vested interest (this is not like my wanting milk for coffee or to open a beer bottle). Instead, I am an intermediary between application-users

and the system kernel: my role is translate what *users* want into system instructions. Granted, presumably the *user* wants the file she's interested in to be opened (as an intermediate step toward getting information from that file). But what I contribite as code are *instructions*, and instructions have an effect on the state of the overall computational environment where my application is hosted. In the general case I am not aware of which new state obtains. Attempting to open a file may cause it to be opened, but it may also cause the software reprsentation of that file — a so-called "handle" — to acquire a flag indicating that the referenced file does not exist (i.e., its path descrribes a nonexistent location), or that it does exist but cannot be opened due to insufficient permission, or that the permissions are satisfactory but there is a temporary lock from another application writing to the file. If needed I could attempt to ascertain the file's state at this level of detail, but it turns out to be irrelevant to my own algorithm. In short, insofar as the "meaning" of computer code are the instructions it emits, these meanings correspond to state-changes only in coarse-grained ways. There may be propositional content associated to each possible state — there are propositions that the file is open, or nonxistent, or inaccessible, or temporarily locked — but the code does not engage the question of *which* proposition is (or becomes) true.

2.2 *Meanings and State-Change*

Underlying both these formal and natural language examples is the idea that the meanings of expressions are associated with changes of something's state: computer statements are instructions to change state and a large class of linguistic expressions are requests to do so. In this vein, meanings are "tools" to effectuate state change or to initiate state-change processes. This perspective is probably incompatible with a notion of "meanings as propositions", because it is hard to see how propositions (or even propositional contents) could be *tools*. The meaning of a hammer is not prima facie the fact that the nail is now in the board.

Granted, whenever there is a state-change there is a corresponding proposition to the effect that something now in state S_2 whereas it was before in S_1. And even if an instruction/request cannot be fulfilled, there is the concordant proposition that something is still in S_1 and can *not* be brought into S_2. So it is trivial to read logical structures onto linguistic evetualities, by leveraging the idea that for any conceivable state of any conceivable state-bearer there exists a proposition that such bearer is in such state.

The problem for truth-theoretic semantics, as I see it, is that these trivial state-to-proposition conversions are just that — theoretically trivial. We should not care about a *trivial* truth-semantic theory. If we have a semantic theory wherein, let's say, "meanings" are really *initiators of state-change processes*, then we can trivially convert this into a truth-theoretic theory. But that is not an intersting truth-theoretic semantics; it is a trivial truth-theoretic theory grafted onto an interesting "state change" theory.

So much is not to call truth-theoretic semantics uninteresting. But for us to take truth-theoretic semantics seriously we need to accept the idea that this paradigm can *motivate* analysis which leads to interesting results, taking us somewhere we may not arrive otherwise. The fact that a given semantic theory has some formulaic translation into truth-thoretic terms does not guarantee that truth-theoretic intuitions actually play an important role in that other theory.

To give a concrete example, I have mentioned Zhaohui Luo's type-theoretic semantics in a couple of contexts here. I think Luo's models are convincing and important, but I also (for what it's worth) have a slight metatheoretical objection, which is that Luo's type theory is (like most academic type theory) presented as a kind of logical system. (I would be similarly curmudgeonly vis-à-vis Shan's monadic analyses, that I mention later, and other applications of theoretical computer science to studies of natural — actually, even programming — languages). The motivation seems to be that logical type theory can define the logical conditions regulating natural-language semantics, as a way to leverage type-thoertic structures to explain natural-language meaning. But this methodology forecloses an analysis wherein logical conditions are tangential to language per se.

We can equally, I believe, develop a type-theoretic semantics as a theory of *typed instructions* or *typed messages* or *typed side-effects*: type theory works in a message-passing or side-effect or instruction-network semantics as well as a truth-theoretic semantics. The

difference is that in the first case we are dealing with side-effects or instructions as phenomena to which types can be ascribed, whereas in the second case we *define* types by fully articulating their axiomatic constraints. The latter is more complete than the former, because in a mathematical type theory we do not take "messages", "instructions", or "side effects" as theoretical primitives. Analogously, a mathematical type theory is more complete than applied type theory as in, say, the C++ type system, which takes the basic structures of the C++ language as untheorized givens (like biological analysis taking medical data as givens). But this is an example of where logical completeness does not necessarily confer greater explanatory merit.

Let's assume that understanding language involves some sort of "messages" communicated between different cognitive processing systems, so the "units" of linguistic processing are embodied in whatever neurological substrata realize cognitive dynamics in general. A type-theoretic semantics would accordingly conceive that there is an architecture of types which we can attach to units of a neurologically realizable cognitive system — analogous to how C++ assigns types to values digitally realized in binary data structures (in practice, byte-sequences). Type theory is not a theory of the substrata that *bear* types. Applied type theory does not *need* to encompass analysis of how digital or cognitive processing works, because that physicalistic demystification is the labor of other sciences. Mathematical completeness is a desirable quality of theories about abstract systems, but both language and computer software are physically realized systems (however abstract their specifications). As concrete in that sense, they are best treated as vehicles of multi-scientific explanatory combinations, where each theory is intermediary between others. In that metascientific sense, as I intimated earlier, completeness is *not* a merit if it isolates a theory from other theories which ontologically complete it.

For truth-theoretic intuitions to be legitimately consequential toward a semantic theory, we need to ascertain to what degree logical structures actually play a cognitive role in how we use language to accomplish things in the world. Obviously, as rational beings our thought processes will be informed by logic and to some degree can be retroactively modeled via logical complexes. But "logic" appears to play a role in these cognitive operations only indirectly. There seems to be some medium — perhaps conceptual roles, or state-changes — that "carries" logic into the cognitive realm. We should reject truth-theoretic semantics if it seems to proceed as if that "medium" can be sidetracked — that we can analyze a logical form in language directly, without analyzing the vehicle by which logical considerations can enter language processing.

2.3 *Truth Conditions are not Polar*

My second quibble with truth-theoretic semantics is that it relies on a certain *façon á parler*. We (in the context of analysis, not at her house) might say something like:

- (66) Grandma wants the proposition "the kitchen window is closed" to be true.
- (67) Grandma wants the proposition "I am cold" to be false.

My prior analysis focused on the fact that the more relevant proposition is that in (67), and we have to read (67) from (66). But it should also be obvious that grandma does not care about *propositions*. She only cares about "I am cold" as a *proposition* because she does not want to be cold.

By contrast, sometimes people care about propositions *as propositions*. A mathematician who has staked her reputation on a conjecture may want the conjuecture to be true. But this desire is not like the desire of a Sanders or a Toronto Maple Leafs supporter to want propositions like "Sanders has won" or "Toronto has won" to be true. Assume the mathematician's conjecture lies in an obscure field where there are no apparent real-world consequences with benefits that can proceed from truth rather than falsehood (it's not like, say, the conjecture will allow her to prove the validity of an encryption sheme she can monetize).

One way to put this is that the mathematician desires a *proposition* to be true, whereas the Leafs or Sanders supporters want certain *propostional content* to be true. But if we have to bring in propositional content, our analysis — so it seems — becomes circular. If the propositional content of "the Leafs win the cup" is that the Leafs win the cup, then a fan who wants the Leafs to win the cup obviously wants the propositional content of

"the Leafs win the cup" to be true — but that's because the idea of the Leafs winning the cup *is* the propositional content of "the Leafs win the cup", reading the quoted version as an operator to make the sentence into a name for the relevant proposition.

Let's say that there are two inverse operators: one maps an idea onto a proposition, and one maps the proposition back onto the idea, which is its "content". A semantic analysis would be circular if it just immediately reversed one operator with the other. Having said that, the reversal may be *separated* by several steps, making it non-trivial. Suppose the Leafs are playing the Jets:

- (68) Are you rooting for the Jets?
- (69) Well, I want the Leafs to win.

The second speaker indirectly answers the first in the negative. This is conversationally reasonable — it does not violate any Maxim of Relevance — because the first speaker has available a chain of inference like:

- (70) There is a proposition (call it P_1) whose propositional content is that the Jets win and a proposition (P_2) whose content is that the Leafs win.
- (71) P_2 entails the negation of P_1.
- (72) He wants the content of P_2 to be true.
- (73) His wishes are only consistent with P_1 being false.
- (74) He wants the content of P_1 to be false.

The interesting steps here are at (71) and (73): in these steps of reasoning the predicate relation between propositions is expressly thematized. In the course of understanding language, there may be occasions when we need to identify logical connectives as implicit to the conceptual framework which a speaker is obviously assuming. In that case we are working with propositions rather than propositional content: there is nothing in the idea of a Leafs victory *a priori* that contains the idea of a Jets defeat. The negative entailment relation only arises in particular situations — when the two teams play each other (and implicitly further restrictions, like there are no draws or suspended games).

It is, in short, a *feature* of a specific situation that the idea "Leafs win" entails the negation of "Jets win"; ergo, logical connectives are one facet of situational models *sometimes* relevant to linguistic processes. Similarly, speaker sentiment is *sometimes* relevant. But there is a structural isolation between these "systems": those "processing units" that can bear speaker sentiment (polarity) are different from those that can bear logical connectives (except in unusual cases, like the mathematician rooting for her conjecture).

When we analyze a fan's sentiment *wanting* the Leafs to win, we are analyzing polarity vis-à-vis propositional *content*. When we observe negative entailment, we are analyzing relations among *propositions*. The proposition "encapsulates" the content so it can be part of logistic structures, where connectives like entailment and disjunction make sense. In computer science, the technical pattern of such "encapsulation" is often called a "monad", and monadic analysis has been adopted in linguistics as well, following Chung-Chieh Shan. We can say that logical propositions *per se* are monadic packages that "wrap" propositional content, subject it to some logical manipulation, and at some later point in processing "retrieve" the content from the proposition. This is not circular because the content is not *immediately* extracted from the monad. In (74), the content wrapped in P_1 is held through several processing steps before yielding the final interpretation (viz., that he wants the Jets to lose). The final extraction corresponds to transforming "He wants the proposition that the Jets lose to be false" to "He wants the Jets to lose". Stated side-by-side, this transform is redundant. The difference is that here the original proposition P_2 is not directly asserted as a linguistic meaning; it rather falls out of a logical process.

On this analysis, there is a *part*, or *substructure*, of linguistic processing that involves wrapping propositional content into propositions. But these wrappings are only meaningful when there is some "delay" between processing steps — essentially, when there is some explicit sense that a given idea stands in some well-defined logical reoation to some other idea. Computer programers can crate "trivial" monads whose behaviors do not deviate at all from an imperative style of programming, but any code written with "trivial" monads can be refactored such that the monads disappear. This is analogous to the circularity between propositional content and propositions: the *meaning* of a proposition *is* its content, so the proposition "monad" has processing significance only when the meaning itself needs to be "held" awaiting the resolution of some logical nexus. If there is no process-

ing structure that demands the content to be "held", then the proposition just "decays" to its content, and essentially disappears.

These points suggest that while modeling linguistic meanings in terms of propositions is *sometimes* appropriate, in the general case it is merely circular or tautological. We certainly should not put forth a theory that the "meaning" of an idea is its proposition — the turth is more the opposite. The meaning of a proposition is its propositional content. So, if we want a truth-theoretic semantics that is applicable for general cases — not just especially logically ordered situations, like a winner-take-all sporting match — we need a truth-conditional theory of propositional *content* separate and apart from a theory of propositions.

I am discinclined to believe that such a theory is possible, since I think we can give a theory of propositional content but I don't think logic would figure strongly in it. Having said that, I should now explain what such a theory of propositional content *should* look like, and I'll lave it as a (mostly) rhetorical question whether this theory does or does not leverage logic or something else.

3 Cognitive and Environmental State-Change

Last section I hinted that I consider meanings somehow bound up with state-changes. This point seems obvious when we openly express state-change desires, like for the window to be closed, but of course a lot of discourse is more about establishing facts or syncing concepts. Compare between:

- (75) Remember that wine we tasted on the Niagara Peninsula last summer? Can you find it in our local liquor store?
- (76) 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 (75) *can* be read as requesting 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 (76) 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 (76) 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 (75) 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.

Having said that, most expressions are not direct requests or suggestions of the "close the window" or "let's get some wine" varity. 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. Nevertheless, we can pursue a semantic theory based on state-change if we stipulate that — even if many changes which occur in the course of linguistic activity do not have immediate, apparent physical effects — there are still multiple kinds of changes that can occur. Dialogs themselves change: the first sentences in (75) and (76) modify the discursive frame so that, for example, a particular wine becoms 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 that the prior frame (but still contained in it; I am not changing the subject entirly). 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.

We are now in position to develop a theory that linguistic manings are grounded in state-changes, assuming 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 a robust semantic theory.

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 frams 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:

- (77) That wine was a Cabernet Franc.
- (78) 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 conext 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.

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 that full definite description (and without the aid of extralinguistic gastures). 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 dtails 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 beliefes 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 spakers 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 " attentions 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 Staffordshires, I would be fuzzier about observational warrants and could end up in conversations like:

- (79) Those dogs are Staffordshires.
- (80) What's a Staffordshire?
- (81) 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 a dog is a Staffordshire (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 itis 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 Stafforshire 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 repertiore 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 Staffordshires" for me: I do not *have* the conceptual machinery to exploit that knowledge, but I undersatnd 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 glase 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 extralinguistc observations, and to understand every utterance in the context of hypothetical extralinguistc observations from which is 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 direcly 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 compeling 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 signifyimg 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. If this gloss is credible, it remains to be discussed whether side-effects like these are just side-effects of linguistic meaning, or are in some sense *constitutive* of meaning. I can understand the intuitive appeal of the former idea, but I think the latter may be closer to the truth. I will discuss these alternatives in the next two subsections.

3.1 *The co-framing system and the doxa system*

It may be argued that a "change-initiation" semantic theory such as I have laid out is, in fact, circular. The meaning of my assertion that this wine is Cabernet Franc is, by that theory, the change that occurs in your cognitive frame as and if you trust my claim. But presumably the only reason you do this is because you understand my enunciation as presenting some proposition, which you can accept to be true. In order for my language to update your beliefs (or indeed to fail to do so, if you doubt me), you have to entertain propositional attitudes to the content of my language. Indeed, your propositional attitudes have to structurally integrate with mine: I am evoking that wine's being Cabernet Franc as an assertion and not a question or request. So you have to identify my attitude to some proposition and on that basis formulate your own attitude to the same proposition. This can only work if my language signifies some proposition — so why can't we call that proposition the "meaning" of my utterance, rather than the effect which my declaring said proposition in some attitudinal package has on you?

The rationale for this challenge would seem to be that propositional content does not belong exclusively to one or another person, or even to the participants in a conversation. Sure, many referential and conceptual details *are* context-specific. But our joint process of cognitive framing seems intended to align our respective frames so that a genuine propositional content can emerge — as we resolve all pronouns, follow all anaphora, and agree on all conceptual roles. Hence from "that wine is Cabernat Franc" we can arrive at a content that thematizes the viniferous properties of some particular liquid. Our interpersonal negotiations may be required to converge our attention on *that particular* liquid, but — once we are there — the fact of its being Cabernat Franc (and

any other culinary, chemical, physical) properties is independent of our collective and individaul framing.

That is, there is a nugget of propositional content that can be designated in a context-neutral way. That content is expressed *in conversation* using "locally significant" terms, for convenience, but those details of *naming* the proposition involved are arguably tangential to the proposition itself. We can, for sake of discussion, imagine a more neutral naming: imagine we could give GPS coordinates for one glass at one stretch of time and thereby refer to the wine in the glass thereby located (call it W) and declare that W is Cabernet Franc. (Meanwhile, let's agree that the concept "Cabernet Franc" refers to a wine with a specific genetic profile — some property "CF" — i.e., *being CF* is an unambiguous biological property that exists outside of any branding or vinological contingencies). It would seem as if my linguistic performance in terms like "that wine is Cabernet Franc" works because you recognize me to be claiming "W is CF". And the only obvious way that can happen is if what I say somehow *means* "W is CF".

Here I am recognizing the intuition that the effect which an asserting act has on addrssees is (skepticism aside) to accept the asserted content as true. The intuition seems to be that the assertion is posed in the guise of something whose truth is independent of the effect it has on the addressee — it's not as if you *make* it true by aggreeing to it. An implicit assumpion is that any competent person would also deem it true — a sommelier and a chemist would confirm that W is, yes, CF. So the idea that meanings are propositional content — motivated by the intuition that assertorial effects depend on all parties' grasping a propositional content that can be lifted outside the immediate context — seems driven by the idea that parties *outside* the conversation would be equally disposed to view the assertions as truthful.

There is, of course, vagueness and context-sensitivity in language. But that does not preclude massaging linguistic content to reduce or eliminate those contingencies — as if there is some subset of linguistic expression that has a basically pristine referential structure, one which allows a certain mathematical precision at least in the areas of designating natural kinds (and designating physical objects via spacetime regions). So, "W is CF", involving only globally meaningful spatiotemporal and genetic designations, would be an example of such "pristine" language. And while people do not actually *talk* in that kind of language, we can argue that when our cognitive frames are correctly aligned, we communicate *as if* we were using pristine language.

The implication of this possibility is that semantics may indeed be logically transparent: the contextual complexities evident in surface-level language are biproducts of our cognitive autonomy, instead of intrinsic to language. They are facets of the minds which are the *vehicles* for language, and so from the perspective of linguistics proper they are "implementation details" rather than theoretical problems. That is, we need to exert conscious effort to synchronize our attentional foci and conceptual mappings with others', given the private nature of our perceptual observations and "inner thoughts": this is why we have both linguistic and extralinguistic signifiers of perceptual frame ("this", "that", "there", "last summer", pointing), and a social infrastructure to conventionalize lexical and natural-kind meanings (why, for instance, usage like "corn sugar" is regulated, not only even by convention, but sometimes by law). But *above and beyond that* we have semantic faculties that trade in propositional contents once we have achieved a proper alignment with our conversational peers. The "alignmnt process" may itself involves language, but language in a different register, meta-discursive more than semantic. Linguistics proper, some can argue, prioritizes the study of communication *after* alignment.

One way to describe this is to posit that what we call "language" is really two different systems: one that effectuates frame-alignment to compensate for the "centrifugal" force of cognitive autonomy, and a different architecture for signifying activity in the context of neatly aligned cognitive frames. For convenience — to avoid debating whether this distinction merely reciprocates, say, prgamatics vs. semantics — let's call this the "coframing" system and the "doxa" system. We could also guess that the hard part of AI-driven Natural Language Processing is the co-framing system; the "doxa" system has enough logical polish that computers can play the game as well as people. A robot in a testing room could geolocate some glass, take a sample to a DNA analyzer, test its profile against a database of cultivars, and conclude that "W is CF". Sure, we need human ingenuity to communicate effectively in the *absence* of "context-stripping"

possibilities: we do not talk in terms of GPS coordinates and laboratory-testable property-ascriptions. But how do we deny that our context-dense language is possible only because there is a logical kernel that *could*, in principle, be solicited in context-neutral terms?

If I say that "the meaning of *this wine is Cabernet Franc* is its side-effect" — how it initiates a procss whose telos is your believing *W is CF* — I can be accused of circularity because I seem to presume what needs to be explained: that my language contains within it a signification of *W is CF* as propositional content. On that objection, if my language did not carry that content, it would not cause the desired effect. And if it *does* carry that content, this given would seem logically prior to the side-effect, since the side-effect can happen only because of the carried content. Ergo, apparently, the *real* meaning is the content, not the side effect (or the process or initiation of the process that has the side-effect).

My rejoinder to this objection is an line of argument that starts by observing the conceptualization whereby the objection can be articulated. Specifically, to formulate the objection, I have tried to imagine a competent language-understander who responds to "pure" or de-contextualized propositional content. My specific example was a robot who tests a wine sample to confirm *W is CF*. In the robot's computational capabilities, language only exists as logical structures: spacetime references are defined as geolocations and timestamps; adjectival qualities are defined as scientific properties computable in the relevant metrics (a genetic profile, a chemical signature, etc.). We can imagine a cohort of intelligent robots listening in on our conversations and translating from our human context-sensitive language to their computable context-stripped representations. By this thought experiment we can — or we can contemplate that we can — imagine robots for whom language communicates propositional content directly. We can imagine sentences "naming" propositions the same way that first and last names identify people.

But is that what is happening? If the robot wants to confirm *W is CF* it has to effectuate certain actions: roll to the right place, take the wine sample, test it, match the rsults to a database. And even if the robot taks our ascriptions on faith — maybe it has a database that matches glasses to both GPS locations and wine styles, to record facts like "this glass has Cabernet Franc" — responding to my assertion still involves some activity (updating the database). So even though we have attributed power to the robot to traffic in logically pure expressions of propositional content, we have not shown that the robot lies outside the side-effect cycles of language.

Let's suppose that there is indeed a "doxa" system within language, so there is a space of logically pristine meanings conveyed via language. As I proposed earlier, a "doxa" inventory — a set of provisional beliefs — forms part of each cognitive frame. When our language-processing faculties encounter linguistic artifacts which express — or within the context of suitably constructed cognitive frames can be translated to — the "doxa system", we respond to those stimuli by (evaluating and then, often) adding the "signified doxa" to the "doxa inventory". But this is still a side-effect: the logical structure of the doxa has a role to play in this overall process, but this is far from authorizing us to reify the doxa as the philosophical core of linguistic meaning overall.

To put it differently, th claim of circularity that I acknowledged is itself circular. Yes, a side-effect due to newly believing P would seem to depend on P being expressed as propositional content by any act initiating the side-effect. And P is a propositional content that can inspire belief-change side-effects because it has the form of a trans-personal articulation: any reasonable person (even a robot) should accept it. The circularity here is that the "work" is done by P, not by the side-effect per se. But in order to theoretically posit P outside the side-effect, we have to posit a kind of decontextualized rational community: P is logically distinct from the side effect because other people and robots should engage it too. But their getting thus engaged is also *for them* a side-effect: to believe or test P the robot has to perform certain acts — i.e., whatever software runs its language-comprehension modules has to call some function than run its database and/or motor-location modules. The enunication of "that wine is Cabernet Franc" is still *initiating a process*.

Insofar as my assertive speech-acts are rationally performed, their side-effects on *one* addressee should resemble their side-effects on others, including other hypothetical or potential addressees (even robots). There is

clearly then a kind of "publicness" or "communalization" of side-effects, and language seems logical if we get the impression that its effects on different listeners will be mostly the same. If there is circularity here, it seems to go two ways: arguably, side-effects can be similar because there is a logical nexus in language that fixes content across minds. Surely "Sanders is a presidential candidate" (stated as a simple fact, without polarity) evokes similar effects because it is objectively true (he has formally declared he's running). So language can guarantee effect-similarity because it has the resources — sometimes albeit not always utilized — to formulate assertions that are relatively transparent, logically (of course, it can also produce provocations like "Sanders is a terrible presidential candidate" or "Sanders is an unelectable presidential candidate").

So communality of side-effects depends on (sometimes, potential) logicality of language. But conversely, it is hard to define the logicality of language without pointing out that logically transparent language (like "Sanders is running") evokes different kides of side effects than polarizing language (like "Sanders is unelectable"). After all, the effect of some logically transparent enunciation is to introduce some propositional content into a public arena. But communication only happens when the content thereby publicized is considered and maybe deemed true, which requires certain cognitive processes in a community of addressees. The logical content of language only "exists" insofar as logically reasonable utterances trigger logically guided cognitive operations.

Even if we accept that linguistic expressions can signify propositional content, this does not mean that a sentence is like a djinn which conjures propositions into material form. Logical structures do not float around like snowflakes: if they exist, they do so as regulatory structures or specifications guiding the behavior or implementation of physically realized, dynamically changable systems. A computing platform can exemplify a Typed Lambda Calculus or Adjoint Tensor Logic or Modal Process Algebra by *implementing* such a system, but this does not mean a software artifact can *be* a logical system (or even can be a *token* of a logical system). But the implementation of the system establishes an Ontological gap between the system as abstract Category and its physical realization.

Let's say, for sake of argument, that someone develops a C++ Functional-Reactive Programming library (a not-too-ambitious enhancement of existing software) which fully realizes Jennifer Paykin's version of Tensor Algebra. It would be entirely possible for most (even expert) C++ programmers to use that library without understanding or even being aware that their code was embodying some logical structure, separate and apart from the system of side-effects and function-calls that they orchestrate. Similarly, developers can create C++ types that are functionally identical to Haskell monads, without being aware of the monadic logic thereby exmplified. To say that logical systems are implemented in software is to say that the totality of all function-calls — both actually observed at runtime and theoretically possible for any run of a program — span an abstract space that is fully and adequately specified by the logic. So we can say that a signal-slot connection causing some function-pointer to be followed represents the concrete manifestation of an abstract "temporal-monadic modality". This means that the pattern of signal-slot connections does and will always conform to regulations that can be modeled via Adjoint Tensor Logic. It also means that this coformance is a result of deliberate design — the logic exerts a normative effect on the software; it is not just a pattern retroactively discoverable in observed function-calls. But what actually exists are the function-calls themselves, and there are many ways to comport to them without considering or being aware of the logic (we can enumerate function calls as a debugger trace, or study them in conventional C++ terms without the added logical details). The logic is manifest as a regulatory and emergent pattern and influence, but is also only one facet of the full ontological status of the vehicles (e.g., function-calls) wherein the logic is realized.

Insofar as Natural Language is logical, I would argue that its logic is manifest analogously: it is realized in the pattern of whatever cognitively corresponds to "function calls"; e.g., the tendency of external (linguistic and otherwise) stimuli to trigger cognitive processes.

My point in this argument is not that linguistic abstraction is wrong: after all, linguistics is not neuroscience, and the theoretical arsenal of linguistics can rightly neglect to target such topics as the neurophysical encoding of linguistic processes. I can accept some form of truth-theoretical semantics if it provides a broad

abstract description of linguistic processes that can be "handed off" to other disciplines, like psycholinguistics and language-acquisition studies. This would be a reasonable "division of labor" if we believed that at the *abstract* level language is really about propositional content, and that notions like "message passing between processing units" are attempts to introduce theoretical concepts at the "realization" level. That is, something like truth-theoretical semantics would be apropos if the *abstract* formulation was mostly logical, even if some formally rigorous (but not in a manner amenable to symbolic logic) model was a better paradigm for studying the *concrete* implementation of the logical architecture.

However, the de facto assumption that "everything abstract is logic", and that any sub-logical details are the tangential impurities of concreteness itself, is a prejudice that isn't borne out even in highly formal milieus. For example, the digital encoding of typed values are a concrete detail counterposed to the mathematical abstractions of type thory, but it's not as if there is a single line between "abstract" types and "concrete" binary-electrical codes. Programming language theory recognizes digital encoding as byte-sequences, and so for any typed value there is a mapping of that value to a string of base-256 integers (the value in runtime computer memory). Moreover, any string of base-256 integers can potentially be interpreted as a typed value (for example, by derefencing a non-correctly-initialized pointer). These are still abstract posits: it requires some abstraction to model electrical signals in disk drives or CPU registers as "base-256 integers". However, this represents a layer of abstraction which stands between the more "mathematical" abstractions of formal type theory and the bare metal of computer hardware.

One feature of this "intermediary" abstraction is that the abstract posits are more likely to be mathematically opaque. In functional programming, for example, we can associate each type with an algorithm that can construct every element of that type, and also often run that construction "backward" to analyze properties of type-instances (which is called "pattern matching"). The canonical example is a list: any list of size n can be derived from a list of size $n-1$ by adding one element to the end of the list. Starting from an empty list we can therefore build any arbitrary list by a sequence of these "constructors". Working in the reverse direction, we can then calculate values — such as, the largest element in the list — by calling a function on every smaller list in the "chain" of constructors: the largest value is the maximum of the *last* value and the largest value of the "predecessor" list wherein that last value is not appended; the largest value of the predecessor is the maximum of *its* last value and the largest value of *its* predecessor, and so on. The recursive structure here is directly tied to the arithmetic encoding (influential in early analytic philosophy) wherein the number 1 is the successor to 0, 2 is the successor to 1, etc. This gives numbers a logical form rather than leaving them as a kind of prelogical Platonic given. The analogous formulation in type theory is that any type is isomorphic to the set of algorithms which generate each of its values — for instance, every list can be associated with the algorithm which builds the list iteratively, starting from the empty list. This introduces a logical structure on types amenable to logical analysis — we can prove properties about functions on types by analyzing how those functions operate on values given the specific construction-chain that produce them. Continuing the example, I can prove something about my implementation of a function on lists if I prove it for the empty list and then prove that, if I know my function works for a list of length $n-1$, and I then append a value, it will still work for the length-n list.

The problem with these functional-programming techniques in the context of programming language theory in general is that many applied type systems do not have this kind of isomorphism between types and construction-chains. In C++, say, I can get a list by dereferencing a pointer, and I have no way of knowing the provenance of the pointed-to memory. There are many ways to construct C++ values *other* than by going through construction-chains. It *may* be that values have properties consistent with their being built up by an incremental, logically regulated proess. However, a C++ programmer often cannot *assume* that types have this logical orderliness. In short, C++ types are more logicallly opaque than, say, Haskell types. This does not make the C++ type system less "abstract" than Haskell's; it just means that there is less information embedded in C++ types which would make them amenable to analysis from a mathematical perspective.

An interesting question is then which language is a better metaphor for *human* language — a functional

language like Haskell, which enforces logical rigor by design? Or a procedural language like C++, whose operational dynamics is essentially concerned with properly orchestrating function calls, even in the absence of logical guarantees? The theory I intend to dvelop here, some variation on an "interface theory of meaning", is probably closer in spirit to C++ than Haskell.

3.2 *The illogic of syntax*

Let us agree that — beneath surface-level co-framing complxity — many language acts have a transparent content as "doxa" that gets conveyed between people with sufficiently resonant cognitive frames. This is still not enough to elevate doxa to the *meaning* of such language-acts. For a logic-driven theory, we have to thematize not only *that* expressions refer to or convey propositional content, but *how* they do so. It is not only the content itself but the "how" that should be analyzed through a logical structure.

Since it is widely understood that the essence of language is compositionality, the clerest path to a logic-based theory 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

- (82) This wine is a young Syrah.
- (83) 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-establishd 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 ineteresting 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:

- (84) The majority of students polled were opposed to tuition increases.
- (85) Most of the students expressed disappointment about tuition increases.
- (86) 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 (84)-(86) 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 (84) and (85) ascribes a certain *quality* to students (e.g., disappointment), whereas (85) and (86) 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 (85), 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 multiciplicity which is within some second multiplicity, and numerically significant there. The sentences differ in terms of how the multiciplicities 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 (85) 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's 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 logicality. 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 (84)-(86) 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 "polled students" 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 (84) 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 (84)-(86). So such details are all still consistnt 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 structurs 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 "polled students". 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:

- (87) Most students oppose the tuition increase.
- (88) 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 (88) the *in*definite article *may* connote a discussion about hikes in general.

But maybe not; cases like these are perfectly plausible:

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

In (89) 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 (90) the plural "increases" could be used, but the indefinite singular connotes the status of tuition hikes as a general phenomenon apart from individual exam-

ples — 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.

Other logical implications may be more circuitous. For instance, describing students as *disappointed* implies that the disliked hikes have already occured, whereas phraseology like "students are gearing for a fight" would have the opposite effect. 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 "dissapointment" — rather than just, say, "opposition" — implies a specific timeline and concreteness, an effect analogous to the definite article. But the semantic register of "dissapointment" 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 "polled students", 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:

- (91) Student after student came out against the tuition hikes.
- (92) A substantial number of students have come out against the tuition hikes.
- (93) The number of students protesting the tuition hikes may soon reach a critical mass.
- (94) 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's 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 a multiplicty 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 (91): 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" our 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 (91) and (92) 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 LGBT). 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 policized confrontation.

All these sentences are of course *also* compatible with literal rioting in the streets; but for sake of argument let's imagine (91)-(94) 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 "etremely angry". However, consider *how* language like (91)-(94) conveys the relevant facts of the mater: 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 (91)-(94) 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 redolant 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 one 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 publicly 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 denoument 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 (91)-(94) similar to those more "journaslistically" captured in (84)-(86). Nor do I deny that the richer rhetoric of (91)-(94) 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 (91)-(94) 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 studnts 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 propositionl 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 trigering *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 dscribed to us from afar. When presented with linguistic reports of not-directly-obsevrable 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 narative/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, an *interface*. To put it as a slogan, *language is an interface to interpretive-imaginative cognitive capabilities*.

If this claim about *language* seems plausible, it has some ramifications for *linguistics*: insofar as language has a formal articulation, it is the formality of an *interface*, which is not necessarily the same thing as the formality of a *logical system*. Insofar as linguistics is a science, it would then be the science of the intermediate space between grammatical plus lexical observations and interpretive-imaginative cognition. Framing linguistics in these terms is, I believe, analogous to describing Biology as the interface from medicine to chemistry and physics — with analogous philosophical justifications and metatheortical consequences. Both can be seen as a larger metascientific exploration of what it means — as a philosophical claim, on the one hand, and as a normative proscription on scientific practice, on the other — for a *science* to be an *interface*.

In the specific context of linguistics, one consequence is that any linguistic structuring element becomes an intermediary eventually handed off to interpretive-imaginative cognitive processes — analogous, in the computational realm, to application-level function implementions setting up kernel system calls. On this comparison, intermediate structures of language understanding are like source code, and interpretive-imaginative cognition corresponds to the system kernel. Insofar as intermediate linguistic structures are analyzed via type theory, we can accordingly model this situation as type properties modulating how language elements carry over to the interpretive-imaginative cognitive "kernel" — which is a faithful analogy to how types work when applied to, say, C++ coding structures. Insofar as linguistic understanding is viewed through the lense of Conceptual Roles, we can analyze how the *conceptual role* which some referent plays — more than its specific referenced nature — determines how it is "communicated" to the "interpretive-imaginative kernel". In fact, this last topic is an analysis I will now consider further.

4 A Multi-Paradigm Interface Theory of Meaning

The phraseology that language is an "interface" — to some (at least partly) prelinguistic cognitive faculties — has been explored before. Orlin Vakarelov, in particular, has developed an "interface theory of meaning" that can be a valuable framework for future research. My gut instinct is to adopt something like an Interface Theory of Meaning (which I'll abbreviate to "ITM"), but at least provisionally theorized as an extension to (or perhaps a foundation for) older language-philosophy paradigms, like Cognitive Grammar and Concptual Role Semantics. I'll spend the remainder of this section forecasting how that might work.

Interestingly, Vakarelov speaks not of "prelinguistic" cognition but of "precognitive" systems. This is partly, I belive, because Vakarelov wants to understand cog-

nition as adaptation: "Nature, in its nomic patterns, offers many opportunities for data systems that can be given semantic significance, it offers ubiquitous potential datums, but it does not offer any well-defined and complete data sets". As I read it, Vakarelov conceives cognitive systems as dynamic systems that try to adapt to other dynamic systms — these latter being the environments where we (taking humans as example cognitive systems) need to act purposefully and intelligently. The "nomic patterns" are latent in our surroundings, and not created by intellect. So *this* kind of worldly order lies "outside" cognition in an ontological sense; it is not an order which exists (in itself) in our minds (though it may be mirrored there). Consciousness comports to an "extramentally" ordered world. However, "precognitive" does not necessarily mean "extramental": there is a difference betweeen being *aware* of structural regularities in our environment, which we can perhaps deem a form of pre-cognitive mentality, and trying to *interpret* these regularities for practical benefit (and maybe a subjective desire for knowledge).

When distinguishing "cognitive" from "precognitive", however, we should also recognize the different connotations that the term "cognitive" itself has in diffrent academic communities. In the context of Cognitive Linguistics, the term takes on an intrpretive and phenomenological dimension which carries noticeably different implications in the "semantics of the theory" than in, say, computer science. Taking Langacker's Cognitive Grammar as canonical, I think scholars in that tradition would agree that we instinctively reach for cognitive frames to interpret linguistically-encoded situations. Research can uncover structural features of linguistic understanding by identifying frequent structural primitives of these frames: consider the landmark-trajector structure in (95), the force-dynamic contrast in (96) vs. (97) and (98) vs. (99), and the spatial/geometric variations in (100)-(102):

- (95) Our house is across the lake.
- (96) I poured wine from a decanter.
- (97) Some wine spilled from the decanter.
- (98) I put spackle on the wall with a knife.
- (99) Paint spattered all over the wall after a can droppped.
- (100) There's a purple-and-blue color pattern all over the wall.
- (101) There are drawings all over the wall.
- (102) There's a plastic sheet all over the wall.

There are underlying perceptual gestalts which seem apparent in these examples, and their linguistic expression seems to take these as cognitive-perceptual primitives rather than grist for analysis (compare to a case like wanting the Leafs to win, when asked about the Jets (, above)). This is consistent with the phenomenological intuition that consciousness includes a primordial structural awareness, and the role of intellect and attention is to focus on local regions of the whole structural cloth of experience, for enactive deliberateness and/or information extraction at a level of precision that "raw" exprience cannot provide. The important phenomenological contrast is not between "sense data", on the one hand, and intellectually filtered or reified world-apprehension, on the other; but rather between a structured cognitive-perceptual complex which we feel as *ambient* experience and, within that, an actively thematized attentional focal-region that we experience ourselves to be forcefully studying and interacting with.

For phenomenology, then, ambient "background experience" is already richly structured and is not really "pre-cognitive", because its structure evinces the "grammar" of cognitive frames. On the other hand, there are other intellectual traditions where "cognitive" carries more of a rational-analytic overtone. I suspect those who identify as Cognitive Linguists understand the word in a more phenomenological mien, whereas the AI and formal logic community places greater emphasis on how cognitive *systems* may be formally tractable. This can yield confusion in linguistics proper, where AI (at least in the sense of Natural Language Processing) and Cognitive Linguistics co-exist. One solution is to qualify "cognitive" in contexts where confusion could arise, e.g. "cognitive-perceptual" as a more phenomenological sense and "cognitive-analytic" as a more computational sense.

Not, however, that the re-occurance of "cognitive" in both terms is accidental: as suggested by the terminological pattern, I think we should see "cognitive-perceptual" and "cognitive-analytic" as part of a spectrum whose "axis" represents attention and dispositional structurality. That is to say, on the more cognitive-percepetual side we may be aware of structural details (cf. Vakarelov's "nomic patterns") but do not consciously attend to them, such that they remain latent as the manner of disclosure of sensate content: for example, the way in which a cer-

tain car appears as red is to appear as a metallic red hue with a glinting lighter patch following the length of the car. This perceptual complex has geometric structure — it is not an undifferentiated red-sensation — but I comport to such content specificity in a passive manner. Towards the other (cognitive-analytic) end of the spectrum, I deliberately seek out awareness of structural forms, analyzing thm in relation to schemas and prototypes (consider a rock-climber planning how to scale a wall). Within this spectrum I think there are continuous gradations; and such a picture seems more phenomenologicaly well-motivated than a cognitive/pre-cognitive duality.

Concepts qua cognitive tools are influential across this spectrum. An architect analyzing the facade of a historic builing will experience its structure in greater detail and attention than a bystander who's meeting a friend in front of the building. The concept "facade" will nonetheless shape how both people make sense of their surroundings. The bystander may have a more passive acknowledgment that she is before the facade, compared to the architect (but it will nonetheless be part of her relatively deliberate attempt to coordinate with her friend's expectation that they meet in front of the building). Moreover, a child who had not yet learned the word "facade" would see the characteristics of buildings' exterior that fall under the concept, but more passively still. Merely learning the word presumably alters our perception of exteriors qua facades vs. "ordinary" exteriors, even if we are not currntly using the word in any conversation — just as the word "hail" sharpens our perception to how hail differs from snow, since we have a compilations of beliefs specific to *hail* (apart from *snow*), and thinking (even if passively) that some precipitation is the former, not the latter, triggers us to activate those hail-specific beliefs. Another analogous case would be identifying milk as actually almond milk, or water as actually salt-water: the more granular our inventory of lexicalized concepts, the more precise becomes the package of prior knowledge we instinctively make on hand in the current situation.

Insofar as knowledge of the word reinforces the concept, we can assume the concept and our disposition to name it lexically is latent in situations where the concept *may* be relevant. Thus the friend might comment on the facade once they have met in front of the building: making explicit something that hitherto the parties, we assume, had just passively noticed. This is an example of the kind of unstated assumptions about others' beliefs that lie beneath explicit linguistic content: "I love this building's facade" presuposses both that the hearer sees the facade and understands the concept.

I use the "facade" example stratgically, to reference Martin Raubal's analysis of this word via Conceptual Space Theory [**?**]. Raubal proposes a "conceptual vector space" to distinguish "facades" from other spatial arrangements that (for instance) we might encounter outdoors in an urban setting. His apparent goal is to quantitatively model the terrain of "facade" in contrast to other, lexically related words, which would yield a basically mechanical, computationally tractable account of how to recognize a facade — perhaps for programming a robot, or a navigation tool for people, as he proposes.

Such potential applications trade on the possibility that we can reach beneath the nuance of language and uncover logically straightforward encodings of, or critriology for, concepts — not unlike my earlier idea of a genetic/vinological "CF" for "Cabernet Franc". Obviously, finding a logical matrix beneath the surface fluidity of language is an essential first step toward legitimate Natural Language Processing.

But trying to map an everyday (e.g., non-technical) concept to a readily-enumerated "feature vector" is not without problems, I think. Conceptual Space Theory is not the same as a prototype-based semantics, but it could share some of its problems when dealing with shape-shifting everyday concepts; the likes of *house* or *restaurant* or *water*. A prototype (or feature-vector) theory of *house* would need to unify mansions with hovels but exclude hotels, tents, apartments, apartment-buildings, and historical estates that have become museums. The criteria for "house" and "restaurant" seem mostly functional, although we are still aware in English of a conceptual incongruity in extending the concept on purely functional terms. We can acceptably use "house", really, for any place of residence — and restaurant for anywhere to buy prepared meals:

- (103) I'm going to a party at my brother's house (suppose he actually lives in an apartment).
- (104) This restaurant has the best Hokkien noodles (said of a stall in a Chinaatown food court).

These feel (at least to my ears) like idiomatic exprssions, however, as if we know not to casually overstretch the concepts. As I proposed earlier, our criteria for concept-mappings seems to be *mostly* functional but to incorporate spatial, configurational, visual, and natural-kind features also as *secondary* criteria. I would argue that a Conceptual Space model intuitively grounded on these latter features would supplement, rather than displace, a Conceptual Role theory (Conceptual Space Theory does account for functional roles, but arguably a little awkwardly).[2]

But setting this objection aside, we can defer to Raubal's analysis to the effect that a "conceptual vector space" can model our disposition to actively or passively identify concept-instances as such. Standing before a building, the proper synergy between properties of a a facade and my own mental "vector" of the colors, spatial arrangements, patterns, and so forth iconifying the idea "facade" — if the synergy resonates enough — primes me to know instinctively that the exterior is a facade, a pasive belief which could potentially be "activated" should that become relevant. One way this could happen is if a conversation partner says something about "this faacde" — entering that referent in the "ledger" of dialogically salient things and topics.

So the efficacy of the concept lies not just in the reality available for us to peceive, nor in our minds, but in a synergy between reality-structures and activatable conceptual models. This kind of partial-but-not-total externalism is perhaps roughly what Vakarelov considers to be "precognitive": the phenomenon of our perceiving an exterior as a "facade" depends on both mental and extramental factors. Gärdenfors Conceptual Space Theory can be seen in this context as an attempt to imagine an "abstract geometry" to quantify (or to suggestively intimate the possibility of quantifying) the world-to-word fit that predetermines (and is witnessed by) well-founded conceptualizations. Gärdenfors's "geometry of thought" can accordingly be seen as an attempt to capture via quantitative intuition an insight Vakarelov's ITM broaches qualitatively: the idea that cognition is a structural *correlation* between the reality out there and what we're equipped to conceptualize.

Perhaps, then, Conceptual Space Theory is (or can be applied for) one example of a Vakarelov-style ITM. Raubal proposes conceptual vector spaces not just as theoretical explanantia but as technological artifacts; he envisions software employing these vectors as assistive technologies capable of some natural-language understanding. A computational system which properly activated the "facade" concept, let's say, given sufficiently proximate feature-vectors, would perhaps exemplify Vakarelov's idea of an "information system" that resembles human cognition, to some functional degree. The fact that such-and-such an environmental given resembles (in the conceptual-space-vector metric) a prototypical facade, or falls in the facade "region" (in a high-dimesnional concept-vector space), acts as a kind of input or signal. For Vakarelov, such quasi-cognitive (or actually cognitive, like the human mind) systems are organized in layers; it is consistent with his subsystem model to say that concept-vector metrics would be recognized by one subsystem, as "effectors", generating signals to be received by other subsystems. One such signal would be, say, a passive awareness that — based on distances in some feature vector — we are now standing before the facade of a building.

Another computational strategy for Conceptual Space Theory is suggested by Kenneth Holmqvist's chapter on "conceptual engineering" (mentioned by Raubal's paper I've cited, but also noteworthy as an unusual attempt to apply computational methods to Cognitive Linguistics). Whereas Raubal skirts around functional-role issues, Holmqvist acknowledges that functionality can be the decisive factor in conceptual frames. He cites the example of a knife, which can on the one hand be prototyped spatially and mereologically (e.g., the relative sizes of blade and handle and the knife's status as the sum of those parts), but also functionally — "Take the lexical unit *knife* as an example ... *blade* and *handle* are clearly parts of *knife* [which also] has *silverware* as a *whole*: *knife* is one of the parts in collections making

[2] For instance, Raubal says that "Meanings of concepts change over time and depending on the context in which they are used. In a conceptual vector space it is possible to account for these changes by adding or deleting quality dimensions and by assigning different saliencies (as weights) to the existing dimensions." Formalizing Conceptual Spaces, p. 5 For sure, our readiness to (continuing my example) accept "house" for any place of residence varies with context: the idiomatic usage in (103) is less proper in the contxt of real estate transactions, or assessing property tax (an available apartment should not be called a "house for sale"). But while "assigning different saliencies" may capture the relative weight of functional vs. more prototype-based classifications, attempts to quantify functional dimensions themselves as if they were, say, colors and spatial geometries — which do have convincing quantitative models (e.g. "red" on an HSV color pyramid) — strike me as forced and unpersuasive.

up silverware. But *knife* can also have *cut* as a whole, because *knife* can be the agent ... of the cutting process" (p. 155). As is clear, Holmqvist adopts mereology as a very broad domain of relations, representing different functional and aggregative connections as special cases of part/wholeness. But more significant is that Holmqvist (given this generality) is prepared to model a broad range of relationships — even if these can in principle be expressed mereologically (like a knife as part of a silverware set), we are not restricted to only visual or physical partonomies.

The parts of Holmqvist's analyses that are more perceptually grounded are also the more prototype-like. He comments, for instance, that "saying ... *blade* is part of *knife* is not sufficient. We must characterize this part-whole relation closer. For instance, the relative sizes of the blade and knife must not deviate outside certain limits. The relative spatial position of the blade and knife must also be correct, i.e., the blade must be correctly attached". This implies the criteria for classifying something as a knife can be quantified, and regions on certain peceptual axes — say, the shape, length, and position of the handle and the blade — carve out (no pun intended) the conceptual space of "knife" from peer concepts like "sword", "cleaver", and "spatula". Certainly such clusters of related lexemes suggest conceptual "terrains" that can be "mapped" — as in my earlier discussion of concept-mapping for water and milk — and Conceptual Space Theory draws on our intuition that such mappings are particularly elegant when there is a readily quantifiable system of dimensions that can be identified, like blade-length distinguishing knives from swords. Again, however, functional pragmatics, more than spatial form in itself, seems to dictate when and how we identify concept-instances with their concepts.

Holmqvist however recognizes this possibility by talking not only of perceptual part/wholes (like blade/knife) but of mereologies with more functional inflection, like a knife in a silverware set or as part of "cut" insofar as "cutting" something can be a perceptual-operational gestalt, whose "parts" are both the agent and patient of cutting. These more abstract mereologies find linguistic expression in cases like:

- (105) He had to cut the crusty bread with a serrated knife.
- (106) The museum had antique butter knives with intricate carvings.

The implied situational picture in each case is structured, in part, mereologically: a museum-piece knife potentially part of a valuable cutlery set; and when slicing bread with a serrated knife the knife is part of an enactive process. However, I'd say the functional position of the knives in these various situations is the key detail, over and above the partonomic significance of situational wholes. A butter knife rests in a different niche in culinary situations than a bread knife. Their roles are however similar enough that we can subsume them under a common knife-concept, although we can likewise distinguish them, *bread*-knife and *butter*-knife forming two sub-concepts.

We should highlight the functional roles because these dispose us to recognize the concept and the subconcpts. We reach for a butter knife if we want to butter bread; it is that practical goal which primes us to see the butter knife as a knife, in general, and a butter knife, in particular. Insofar as there is a synergy between our mind and our environment, manifest in the adequacy of concepts like "butter knife", this is primarily a matter of — in this case — the object conceptualized as a butter knife being suited for that task. Of course, part of the reason *why* it is so suited is how it is shaped and manufactured. Geometric and physical details are therefore relevant for our inclination to identify (butter) knives. Mostly, however, these details are derivative on functional roles, rather than the preeminent criteria of conceptualizations.

Having said that, an unused butter knife is still a butter knife. Table settings include butter knives so we can conveniently reach for one as needed. Our appreciation that we *might* need a butter knife, or how *some* diners might need one, and how they are used, informs our conceptualizing dispositions. It is true that perceptual details like color and shape provide visual cues to the nature of objects — partly because they need the design and material composition they have to perform their intended purpose. But we don't just troll sense-data looking for cues; our perceptual awareness is not a matter of decontextualized equations like "shiny and sharp means *knife*", "liquid and clear means *water*", etc. Our receptivity to concept-instances depends on our awareness of current situations. It's not like we are prepared to see examples of every kind of object that we are

familiar with in every situation. We anticipate finding butter knives on a dining table, or in a kitchen. Situational awareness brings with it a selective anticipation — knowing what kinds of objects are likely to be associated with each situation prevents our having to devote excess thought to identifying objects, or misidentifying similar-looking ones.

So even if we accept features like color and shape as "triggers" for concept-recognition, our receptivity to these triggers is conditioned by situational understanding — which is an example of cognitive frames. These frames, moreover, are defined in terms of functional roles: the salient characteristic of a bread knife is the fact that it can cut bread, and the salient characteristic of a butter knife is the fact that it can spread butter. The situation provides the conceptual slots that objects can fit into.

Situational understanding does, we can say, proceed from *situational* prototypes, so here is a domain where prototype theories are appropriate. Instead of a prototypical *knife* (or house, restaurant, corkscrew, etc.), I think we have prototypical situations where knives (etc.) play a role. Any particular knife is conceptualized against such a background: one kind of scenario is someone at the head of the table ceremonially carving a roast, wherein the knife is a "carving knife"; another scenario is someone spreading butter, wherein it is a "butter knife"; etc. Each situation-prototype is an architecture of roles, where for instance there is a person enacting the carving ritual, the instrument she uses, the food being carved, and so on. The building-blocks of these architectures then become solicited within language, for instance via case-markers like benefactive, locative, patientive: "carving *the turkey* for *grandma* with *the knife* at *the counter*".

In practice, our sensitivity to functional roles allows for ad-hoc practical configurations, like using a hammer as a bottle-opener. To the degree that situation-prototypes are *abstract* models, we nonetheless have narrower appraisals of functional roles: the lexeme "bottle opener" covers objects playing that role in *prototypical* situations, which is why it does not cover hammers. This is one reason why we should accept conceptual-role talk as more parsimonious than functional-role talk: conceptual roles *are* functional roles, but tapered down by the prototypicality of situations abstractly conceived.

In practical affairs, of course, we comport to real situations — that may embody situational prototypes, but no real context, with its idiosyncratic details, is entirely prototypical. This concreteness has a pair of distinct implications for my current analysis. First, we accept localized expansions of conceptual roles, like bottle-opener-to-corskcrew or even -to-hammer. Second, conceptual roles offer templates that allow cognitive-perceptual judgments to be passive or instinctive — we reach for a butter knife without being aware of concluding that said instrument is a butter knife, or even really being aware of knowing that a butter knife is there.

So the practical purpose of curating a "library" of conceptual-role accounts is to prime us, given each situation, to identify objects fulfilling conceptual roles *passively*, as part of unattended, background consciousness. Once we become aware of specific enactive needs — the thought that we need a knife or a corkscrew, part of some practical task being now phenomenologically active, a focus of attention — the more passive perceptual details (like a knife's shape and color) are poised to trigger more active concptual recognition. Now we become consciously aware of the butter knife nearby, and of picking it up and using it.

Perceptual details can certainly be triggers of conceptual recognition, but a complex interleave of situational awareness, situational prototypes, pre-learned conceptual roles, and moment-to-moment enactive needs and processes, all establish an infrastructure within which perceptual content can actually "trigger" determinate conceptualizations. Most of this activity is prelinguistic — it establishes a cognitive baseline that language builds off of. But there is enough commonality between different persons' situational models that we can understand how these cognitive processes are working for other people, and therefore can draft them into the circle of language: if we, holding a slice of bread, ask someone for a butter-knife, we trust they will instinctively grasp both my enactive requirements and have the cognitive resources to help achieve them.

In sum, our ability to convert passive situational awareness and "background consciousness" perception, mediated hy situation-prototypes, into active cognitive-perceptual conceptualizations and pragmatic representations (of the "here's a butter knife I can use" variety) is

itself, in total, a cognitive system which can be *targeted* by language, however much it is itself prelinguistic. That analysis, if it holds water, would make language an *interface* to the aforementioned cognitive system. Under that interpretation, my reading, originating in Conceptual Space Theory and then pivoting to Conceptual Roles, also presents as a flavor of ITM. I envision this hybird thory as a kind of synthesis of Conceptual Space Theory, Conceptual Role Semantics, and (at least some variant on) Vakarelov's Interface Theory of Meaning.

Situational awareness, and situationally-mediated object recognition and associated conceptualizations, are highly subtle and multifacted cognitive faculties — especially in our purposeful, socially normative, often emotionally charged human world. Some aspects of this overall architecture may be interestingly modeled or emulated with computers. Examples include Raubal's and Holmqvist's implementations based on Conceptual Spaces, or Holmqvist's approach also intended to present computational models of Langacker-style Cognitive Linguistics, a goal shared by some other work, like Matt Selway's [**?**]. To this we could add certain models embraced by phenomenologists like Barry Smith and his collaborators (notably [**?**]) and Jean Petitot. I am skeptical that computer implementations will ever achieve more than a rough approximation of human enaction or language understanding — valuable perhaps as a research case-study and for specific useful tools, but nothing like robotic substitutes for human bodies and minds. But computer tools can still play an important role in research, by giving formal outlines to cognitive architectures which appear to have some formal dynamics, even if the raw materials of cognition — like sensation, situational awareness, and empathy — may not be formally tractable.

4.1 *Distinguishing Computational Models From AI*

I contend we need to tease apart the pursuit of valuable computational tools and models from an (often reductionistic) paradigm of seeking artifical, computationally engineered replicas of human cognition. *Computational* does not have to equal *AI*.

Holmqvist's and Selway's research that I have cited are good examples of paradigm-overlap between cognitive and computational linguistics. I will cite other scholarship which also finds philosophical inspiration in cognitive linguists like Langacker, Gärdensfors, George Lakoff, and Eleaonr Rosch, but which also target cognitive-science formalizations and "cognitiv architecture": [**?**] etc. A recurring pattern in this scholarship is to *first* propose a structural intermediate representation — a model of intellectual structures which plausibly embody the processing of language and cognitive-perceptual content, partly abstracted from surface-level sensory or signifying details — and *second* propose algorithmic or software models of how our minds translate linguistic and perceptual givens to abstract, or partly-abstract, schema.

I have argued that we bring abstract situational prototypes to bear on understanding all of the world and social situations around us, and that language taps into these models so that people can coordinate situation-appropriate activity. Given that there is an abstract and scehmatic dimension to how we understand situations, we should expect a partially abstract sheen to how we intellectually engage objcts and concepts once they are situationally "located". Having identified objects as butter or carving knives, pitchers or glasses of water, wine or beer bottles, corkscrews and bottle openers — identifications themselves mediated by situational awareness, viz. if we are hosting or attending a dinner party — we no longer often attend actively to sense-perceptual minutiae. Our mental map of our surroundings — there's the corkscrew, there's the carving knife — pulls these referents outside the register of sensate consciousness and into the pragmatic hum of worldly activity. Insofar as they nestle in our intellectual faculties in that semi-abstract state, it seems fair to capture the schematic, structural appearance they have in this intellectual register — phenomena without the full-cloth phenomenology.

This in turn seems to invite us to imagine how the structural essentials of such "pragmatic appearance" may be captured by computers. We do not need to endow computers with human consciousness or emotions, because our mental traffic with the corkscrew or carving knife at some point evolves outside the sensate and passionate fabric of momentary consciousness. There is a schematic and mechanical dimnsion of human action, and we can imagine computers simulating human intelligence at least on *that* theatrical level.

Or at least, such seems to be the intuition behind attemps to model our human representations of objects and concepts in terms of abstract structures. But even a feasible theory of these semi-abstract layers of cognitive processing is only half the story. Suppose we agree that there are legitimate cognitive insights in Holmqvist's model of cognitive frames, incorporating (but also extending, including in a more pragmatist direction) Conceptual Space Theory — employing a generalized mereology that renders objects and concepts as *parts* of situations (I have suggested a more conceptual-role account for analogous phenomena). Suppose also we find plausible cognitive-frame models in Selway's intermediate representation for natural language, via which his proposed implementation can potentially map natural language to formal specifications. In these cases we hagve potentially valuable Intermediate Representations which capture cognition, in effect, mid-stream, or in-the-act: neither conscious phenomenology nor neurophysical hardware.

Howevere, Holmqvist's and Selways' work appears to operate in an environment where these Intermediate Representations are valued primarily because and insofar as they allow human cognition to be mechanically recapitulated. This of course demands not only that compuers *represent* IR models, but also *create* them — that is, when presented with an artifact of natural language, or the visual data of a scene, that computers should *automatically* map these givens to the theorized IR models, as if retracing the steps of human intelligence.

But just because IR models can be given computational form and representations, it does not automatocically follow that automated generation of IRs is possible or effective. We can and should thereby distinguish the computational *study* of cognitive Intermediate Representation from the AI vision of programming computers not just to *host* but to *derive* Intermediate Representations. I am sympathetic to the former methodology but skeptical of the latter.

I also believe that most research in, e.g., computational linguistics, ends up conflating those two goals. In that case, IR models are judged based on whether they facilitate automated, AI-driven generation of IR, not on whether the IRs are insightful suggestions of how human cognition itself builds an intermediary cognitive register — paricularly if we accept Vakarelov's overall picture of language as an interface between speech-givens and prelinguistic cognitive fsculties. Interface theories and Intermediate Representations tend to go together — the IR is the representation of some input during intermediate processing yielding an output; a structure between two other structures, where the role of the interface is to bridge the structures as well as to activate the correct capabilities via the output. This is the architecture of an "interface theory", in science or computer programming; it carries over to linguistics of we take Vakarelov's ITM seriously.

An equally intrinsic aspect of interface theories, however, is that the processes operative at the intermediate level aree theoretically distinct from the realms which the interface bridges. For example, the theory of programming-language compilers and runtimes is distinct both from the theory of programming-language parsers and specifications, and from the theory of CPU architecture and system-kernel development. Runtime engineers can work through the medium of IR models, and compiler design itself is split between parsing surface-level source code *to* IR and mapping IR structures to their proper runtime paths of execution. It would be a breach of design architecture to attempt to solve source-to-IR problems within modules devoted to IR-to-runtime engineering.

Unfortunately, I get the sense that AI research does not respect a comparably disciplined Separation Of Concerns. There are multiple parts to a typical AI platform — modules for representing information (or knowledge/facts/beliefs, or the state of the system's physical or digital environs, etc.); for populating these reprsentations with data deliberately introduced by human users or absorbed via some real-time engineering from the outside world; for analyzing reprsentations to glean insights or calculate a course of action. Individual parts of the overall architecture can evince notreworthy engineering achievements, separate from the goals of the overall system. In this sense the pursuit of AI can yield positive contributions in other branches of computer science and other disciplines, without the stated rationale of AI realizing (and monetizing) systems that exhibit humanlike intelligence.

So perhaps "AI" is best understood as shorthand for a suite of research agendas across several aspects of

computer science, not restricted to the fields — like Machine Learning, Robotics, and Artificials Neural Networks — that are publicly associated with the term. This is not, however, how AI seeems to be represented by companies and institutions (including in academia) who have a vested interest in the products AI may yield. A benevolent reading would be that institutions understand the diversity of research that can be loosely aggregated under the AI umbrealla, but use the particularly science-fictional facets of this science to excite public support: visions of humanoid robots and conversationalists provide a compact story to that is more meaningful to non-experts than technical outlines of the intermediate machinery beneath the hopefully-intelligent surface. However, a more cynical interpretation is that AI is valued as a cash cow, and residual disciplines which contribute to the engineering infrastructure that AI requires — but are agnostic as to the AI vision itself — are appreciated only so much as needed to keep the AI project moving forward. On that interpretation support for AI-agnostic research becomes lukewarm and transactional, and actual innovation in such areas may not be properly celebrated.

This situation is not irrelevant to either linguistics or to Cognitive Phenomenology. In Computational Linguistics, for example, linguistic IR models seem to be valued based on their utility in AI-driven Natural Language Processing. This presents a disciplinary bifurcation, where potential computational models are *either* connoted rather informally as part of a thoretical investigation among linguists (or philosophers of language, etc.), *or* concretely implemented, in some kind of software package, but then measured as components in a Natural Language Processing system: assessed on the basis of how the system overall approximates human language understanding via artifical means. Another genre of formal models, such as the type- or monadic theories I have alluded to here, may also have potential software incarnations but tend to be developed instead in a mathematical style, effectively "programming" in the abstract space of theorems and syllogisms rather than actual compuers. Each of these methodologies skirt around the potential intermediary tie: concrete computational systems that are designed as exemplifications of semantic, grammmatical, or pragmatic theories, presented as hands-on software to anchor theoretical discussion but also intended as tools to advance the human study of language, rather than as steps toward synthetic avatars.

At the same time, there is another side to the story: software implementations offer a focal center for research, something tangible that scholars can experiment and collaborate on. The AI story provides a target goal; it helps developers understand the local, technical code they are working on by connecting it to a larger system. Whatever philosophical objection one may have to AI initiatives, we should recognize the value of expanding academic and institutional practice beyond just writing and reading research papers. Insofar as part of one's scholarly modus operandi can include writing computer code, and studying code repositories developed by others, we can benefit from a hands-on, even trial-and-error kind of experimentation.

In effect: software which can be given concrete tasks — if it does *this* properly (whatever *this* is), then there is some larger thoretical point that is demonstrated — and then, incrementally, evolves to realize those tasks, provides a distinct form of intellectual engagement. We get *that* to work, then *that*, then fix *that*. This kind of "code-and-fix" cycle is quicker than conventional research, especially in the humanities, where the routines of authorship and publication and conferences can feel like they are unfolding in slow motion.

Perhaps for this reason, some of the most interesting cognitive models hacve come from computational and academic environemnts informed by ambitious "Artificial General Intelligence" programmes, like Carnegie Melon University's OpenCog, and the "lmnTal" project at Waseda University in Tokyo. These projects both employ formal-semantically expressive, hypergraph-oriented data systems that embody both the structural and procedural dimensions of computer systems — manifesting theories of both the execution of computational processes and the representation of formalized information. These are important models even outside the Artificial General Intelligence ideology.

In fact, these are models which in linguistics and phenomenology may deserve more attention than Artificial General Intelligence *qua* philosophy. But we should not discredit the role that Artificial General Intelligence may provide as a kind of intellectual compass helping scholars and engineers reason through the intrestitial machinery

which may in fact be more real than the philosophical vision, but also less effective as theoretical *vie ferrate*. Metaphors can triangulate research whereas analogies guide transfers of theories or methods between fields — i.e., analogies are more trustworthy landmarks than metaphors for surveying the envisioned future of a science — but metaphors can still be intuitive guides; maybe AI and Artificial General Intelligence can stabilize into our overall science and philosophy as a modest but suggestive metaphor.

5 Cognitive Grammar and Type Theoretic Semantics

The emergence of Dependency Grammar as a *computational* approach has some broad implications. The historical preference for phrase-structure foundations — among those who actually build Natural Language Processing code libraries, in disciplines related to Artifical Intelligence — arguably reflects how phrase structure more cleanly models a theory of linguistic meaning and signification based on "symbolic logic" — a theory that the *meaning* of a complete and self-contained linguistic expression is the logical state of affairs which it asserts or in other ways connotes. Correlated with this assumption is the idea that phrase structure logically transforms its constituent parts; so from the word "students" we can form the phrase "many students" to designate a kind of plurality — a plural set but also, more specifically, a set which is reasonably large relative to some context. In the hierarchical model presented by these norms, phrases subsume the roles of individual words and represent discrete semantic units with respect to still larger phrases.

It is certainly true that one role for phrases is to satisfy a semantic niche — often a place occupied in other (or even the same) language with single words, or vice-versa. The French "laisse tomber" translates the English "drop", for example; and "parliamentarian" is a more exotic version of "Member of Parliament". There is no evident pattern for when a single concept is conveyed, in one language or another, by a single word or a multi-word phrase. Moreover, the meanings of phrases are influenced by semantic conventions no less than are individual words, and they are not solely a product of phrase constituents. Semantics is guided by what people need to talk and write about often; when events in a linguistic community call for some fairly rigid and repeatable designation for an important concept, the resources of language adjust to provide that role, either through a complete neologism, or a lexical variant — a new usage; or the entrenchment of a phrase. In current events, the expression "Syrian Refugees" recurs when discussing people displaced by the Syrian civil war, and potentially other interrelated conflicts also; convention seems to allow that nominal "Syrian" Refugees don't have to be Syrian nationals. The meaning of the phrase is fixed by its niche in familiar discourse more than by its literal form. Phrases exhibit conventionalization and usage pressures analogous to single words; which lends credance to the notion that phrases subsume the role of single words, and that the semantic contribution of words to sentences is determined through the phrases where they occur.

On the other hand, it is well established that words' contributions are not *wholly* subsumed by their surrounding phrase-structure. The famous joke about the Holy Roman Empire — or its reprise in the current line that the Islamic State is neither Islamic nor a State — point to evidence that as language-users we still hear the individual words outside their phrase context. To subsume a word into a phrase is also to suggest a particular semantic (and pragmatic, real world) interpretation, one which conversants may challenge.[3]

Arguably, joking or titular cases like "Holy Roman Empire" can be relegated to thematic margins, especially if we accept formal-logical construals of what semantics is all about, with an *a priori* contrast between Semantics and Pragmatics, the former rooted in *states of affairs* and only the latter addressing rhetoric and usage. Counter to this counter-argument, however, we can observe that different phrases imply different degrees of "autonomy" to their constituents, and different degrees of coherence or unification into a single idea. Some phrases act as direct substitutes for single concepts (like "Member of Parliament") where it seems mostly historical accident that a phrase rather than a word emerged as

[3] How literally to take phrases is a notorious source of political controversy: recall debates about the relevance of Afghanistan for Iraq, in US policy, and Rudy Giuliani saying "There *is* Al Qaeda in Iraq — it's called, 'Al Qaeda in Iraq'".

the most popular; but many other phrases have more complex usage scanarios, including everyday expressions that don't have special rhetorical or sociolinguistic conventions that would make them tangential to semantic or syntactic analysis proper. Moreover, many of these examples are similar to those used by Cognitive Grammar to challenge the syntax/semantic distinction and argue for "morphosyntactic" models as reciprocating cognitive formations, not abstract language-rules.

For example, in Ronald Langacker's *Foundations of Cognitive Grammar*, the sentence

▾ (107) 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.[4] 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 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 [22]; [12], but we need to append Mental Space analysis with 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. This complex interplay of phrase-structures is hard to accommodate from the grammar-hierarchy perspective. There seems to be no way to break down this example sentence into a tree-like phrase hierarchy wherein each phrase, considering the semantic concept which it is apparently tasked to put into words, can be seen to function in isolation. The mapping of the sentence to a logical substratum would be more transparent with a sentence like "Three students asked interesting questions"; that sentence is a more direct translation of the facts which the original sentence conveys. But this "more logical" sentence has different connotations than the sentence Langacker cites; the original sentence 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 expression relative to cognitive process 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,

[4] For example, [39, pp. 119 and 128], discussed by [11, p. 189], and [48, p. 9].

particularly with respect to singular/plural agreement.

- (108) Time after time, tourists (a tourist) walk(s) by this building with no idea of its history.
- (109) The streets around here are confusing; often people (someone) will ask me for directions.
- (110) Student after student came with their (his/her) paper to compain about my grade(s).
- (111) 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 cogntively complex way, recognizing connotions 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.

This is not to say that phrase-structure paradigms are refuted by these examples. Cases like these can be accommodated by layering new structural rules, such as allowing exceptions for singular/plural agreement in the presence of certain "lead-in" phrases like "Three times". It is not even accepted that these examples clearly favor inter-word relations (as language formalization, in preference over phrase-structure trees) — cases like "Student after student" have also been used *against* Dependency Grammar on the argument that there is not a clear "single" word, in that phrase, which should be seen as linking with words elsewhere in the sentence [46, pp. 400-401], [45, p. 2]. It seems arbitrary to select either "student", or "after", as "the" representative of the phrase to link with — for example — the verb "complained"; on that argument, the least arbitrary analysis is to treat the phrase as a whole as a single unit for purposes of grammatic linkage. In short, both paradigms have potential problems with these example. Considering "Student after student" as an encapsulated phrase leaves the singular/plural flexibility in the continuation of the sentence unexplained ("Many students compained about ?his grade" is clearly dubious, so "Many students" is not a direct substitution). But bracketing the phrase when decribing the sentences' "linkage" leads to an apparently arbitrary choice when it comes time to notate the subject/verb linkage for "complained". I will address this particular ambiguity later; but for now I'll just point out that a simplistic reading of both Dependency and Phrase-Structure ideas seems to run aground.

5.1 *Comparing paradigms*

Since Computational-Linguistic paradigms find practical expression in code libraries, there are some options to assess competing theories empirically — comparing libraries' speed, accuracy, ease of use, and how readily can they be modified in light of new research. Arguably, however, the quality of a code library does not automatically reflect the accuracy of its underlying linguistic paradigms (as opposed to the skill, foresight, and resources of its programmers); not to mention that more complex analyses of human language may be both more correct and also harder to express in code. There is, in any case, no apparent consensus amongst linguists and programmers that one or another language theory has proven computationally preferable. Another approach to theory-comparison involves considering the range of linguistic phenomena which different methods can explain, without resorting to ad-hoc compilations of exceptions and special cases. Arguably, here, Dependency Grammar provides more straghtforward explanations. For example, the internal structure of phrases seems to lend specificity and nuance to their meaning in ways that get lost when trying to replace phrases with logico-semantic equivalents. "Student after student" is not losslessly substitutable with "Many students", and the former phrase has a temporal and multi-tier cognitive implication which the latter discards. The second phrase is compatible with "Many students" complaining *at one time*, as well as drawn out over time; the former phrase appears to clarify that the second kind of situation is the intended meaning, Of course, in context, the two phrases may be understood to have similar meanings; but this is a product of how the linguistic structure relates to its presumptive conversational

context, not to an intrinsic semantic equivalence. I will now consider these and other examples to discuss the dependency/phrase-structure contrast in a little more detail.

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 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.

Clearly the two phrases are therefore semantically different; but notice also that the semantic properties of the first phrase are due explicitly to its internal structure. The temporality implicatures could be expressed in a more "purely" semantic fasion with a choice of wording, like "a procession of students complained". This would rely on the conventional meaning of "procession" (or "stream", "sequence", etc.) to provide the expressive "time" dimension. But the "Student after student" phraseology achieves this effect more economically and with more "oomph" because the internal repetition in the phrase itself effectively models the recurrence it seeks to feature semantically. Here linguistic form actually does reproduce factual structure, like a syntactic version of onomatopoeia. This fact of internal structure clearly can only be fully modeled by taking seriously the exact composition of the phrase, not treating the phrase-structure as a convention fully subsumed by a semantic role.

In addition, aside from the expressive detail which depends on the actual phrase structure (which therefore cannot be summarized away), this inner structure also governs morphosyntactic possibilities over all. "A procession of students" captures a similar temporal progression but also fully absorbs "student" in a plural guise, and "A procession of students complained about ?his grade" is straightforwardly ungrammatical. In Langacker's "Three times" example, the inter-word "linkage" captures the aforementioned complexities in a reasonably non-arbitrary way, I believe. "Student" is linked as subject-to-verb with "asked", and as subject-to-object with "question". It is true that these link-pairs seem to violate agreement norms, but there is nothing in the Link Grammar paradigm — which practices Dependency Grammar with a rather detailed and intricate inventory of inter-word relations, or "links" — mandating that *all* link-pairs exhibit forced agreement (like singular/plural). Agreement, when it applies, is a property *of* link pairs. There is also an implicit (cross-phrasal) link between "student" and "Three" — clarifying that, considered in its entirely, the sentence is about three students precisely — and the presence of this kind of link alters how the other links connecting to the word "student" are assessed. In particular, this latter link stipulates that the word "student" is being simultaneously understood in both a plural and a singular sense, so it permits singular *and* plural link forms which, more commonly, could only be singular *or* plural. So link grammar can offer an elegant analysis of singular/plural "underdeterminism", expressed in the same underlying graph-context terminology as most other link-grammar theorizing. It would be unfair to use this as a case against Phrase Structure grammars without a detailed presentation of how these grammars would handle such a case in turn, but I'd argue that link grammar accommodates this complex example with relatively little departure from its underlying theoretical and notational or presentational commitments.

While my previous examples contrasted Phrase Structure and Dependency Grammars in terms of their resources for explaining sentences with unusual semantic patterns but relatively clear meanings (in context), another form of comparison can address actual ambiguity. Consider

- (112) The Maple Leafs failed to win in overtime for the first

time this year.

- (113) The Maple Leafs failed for the first time this year to win in overtime.

The first can mean either that the Leafs had won *all* or *none* of their prior overtime games. From a phrase-structure perspective, we have to image that "to win in overtime" can "migrate" so we hear it as in the second version of the sentence. For more inter-word grammars, the alternation is simpler: "for", initiating the phrase "for the first time", can be linked with either *failed* or *win* — notationally, it amounts to the presence or absence of one graph-edge, when the syntax is represented as a graph with inter-word labels for link kinds. This could be a distinction without a real difference, since choosing which inter-word link to recognize triggers linking in the rest of the phrase along with it. But perhaps reflecting on how we process the ambiguity — realizing that there are two competing parses and deciding which is the one intended — we picture the alternatives more as "horizontal" options for connecting threads across the sentence, more so than a "vertical" organization where we hear "for the first time" as "contained" in a larger phrase. My own feeling is of exploring competing relational patterns more than exploring different ways that the phrases can be nested inside each other.

That being said, how much of our sense of ambiguity (or clarity, for that matter) is driven by meaning, not form? The "double parse" just examined does not always generalize to similar cases:

- (114) The Maple Leafs failed to win two consecutive games for the first time this year.

The reading as in "this is the first time they failed to win two consecutive games" makes no sense — unless you've won every game, but perhaps the first, you've at some point lost after a win. Is this case anomalous, where a syntactic ambiguity idiosyncratically fails to yield logically plausible readings? The ambiguity is found in *failed to make the playoffs for the first time since 2013*, and many *for the first time this season* cases, like *beat the Habs*, *sell out the arena*, *score a goal in the first period*. But "failed to score a goal" is almost surely read that they *did* score in every prior game. Do we hear the construction as intrinsically ambiguous, and reject one reading only when it is clearly flawed pragmatically?

If we believe that language understanding unfolds in a predictable operational sequence, then we should assume that both parses are deemed plausible, and semantic considerations only retroactively eschew one reading (if they do so at all). This would explain why in many cases the ambiguity persists enough to cast the practically intended meaning in doubt. But that account does not consider the temporality of language itself; the hearer does not know in advance that a trailing phrase like "for the first time this season" is coming, and starts to make sense of the sentence up to there; once then hearing or reading the addendum, the audience instinctively has to interpret the final phrase as deliberately inserted to modify an already-complete idea. On this analysis, the addendum is initially approached as a performative detail, something said for a reason to be determined — it is not structurally necessary to make the sentence well-formed. Perhaps we then try to fit the last phrase into the sentence both syntactically and semantically, together, triggered by a pragmatic phenomenon (the speaker's choice to add on to a seemingly complete thought) which then becomes logically prior to both syntax and semantics. If this is plausible, it supports an inter-word relational model because we are forming a picture of language structure relationally, assimilating new words and phrases to those already heard by linkings referring back in time, rather than waiting until we are sure we have a complete sentence and then treating it as a static structure to vertically reconstruct.

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

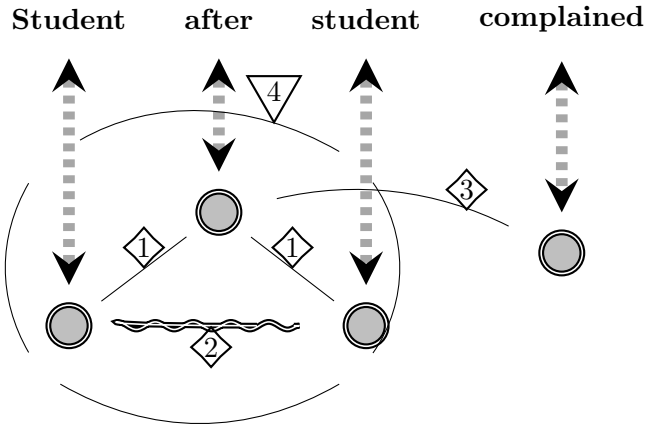
will influence taking "A lot of" as the "many" variant of choice. So speakers have leeway in choosing grammatic forms that highlight one or another aspect of situations; but they also have leeway in choosing rhetorical and stylistic pitch. Both cognitive framings and stylistic performance can be factored when reconstructing what compels the choice of one sentence over alternatives.

One consequence of these analyses, should they be accepted, 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, Cognitive and Applicative Grammar (CAG) considers phrases as "applications" of (something like) linguistic or cognitive "functions", in the sense that (say) an adjective is like a *function* applied to a noun, to yield a different noun (viz., something playing a noun's conceptual role) [20]. I will consider related "functional" and (by extension) Type-Theoretic approaches in the next section. But we should not read these transformations — like *Syrian refugee* from *refugee* — 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. This argument rests on a vantage point from semantics as well as syntax; therefore, I will discuss it briefly at present (I return to this analysis at greater length in the next section).

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" students, 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. So *a student complained* focuses not on the numeric count of one, but on a singular event (unlike "*only one* student complained"); *students complained* focuses not on the plural measure of students involved, but on the fact that a certain type of event happened several times. *Many students complained* focuses not on sheer number (unlike *a large number of students complained*), but rather on the implication that complaints were widespread enough to represent a significant sample, perhaps a majority sentiment, among the student body. The semantics of the former two forms seems to focus attention on the *events* of complaining, while the *many students* construction seems to focus more on their suggesting a prevailing attitude. "Students complained" seems to single out each event as distinct, even though there are several of them; whereas *Many students complained* seems to construe the events as each resembling the other, to the point where they partly lose their individuality. "Isolated events", in the English idiom, are those which are atypical; as we cognitively shift from the events as discrete to recurring patterns, they become suggestive of a larger state of affairs. By implication, if many students complained, many other students may be unhappy; the extent of students' unrest is no longer measurable by the multiplicity of the complaining-events.

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. Formal models of

Figure 1: Dependency-style graph with argument repetition



♦ 1 Head/dependent relation
♦ 2 Argument repetition (——`after`—— idiom)
♦ 3 Propositional completion ($V :: N \dashrightarrow \mathcal{P}rop$)
▼ 4 Phrase (modeled as applicative structure), typed as N^{+}

syntax and semantics often borrow notation from formal language theory; for example, notations for Parts of Speech lifted from functional programming languages.[5] This notation can help us picture the "flow" of ideas building up to a complete sentence, formally represented via type theory (where sentences reveal a type hierarchy culminating in a self-contained idea, that is, a proposition); more informally we can picture a similar "conceptual" flow tracing how listeners come to make sense of the language they encounter enunciated by speakers. By way of illustration, Figure 1 shows a Depency-style descructuring, with implicit type annotations. As this shows, the "Student after Student" idiom can be notated as, say, `after` :: $N^{\odot} \dashrightarrow N^{\odot} \dashrightarrow N^{+}$ (using $N^{\odot}$ 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 $N^{\odot} \dashrightarrow N^{+}$ transformation is not *the* morphosyntactic meaning, but instead the skeleton on which the full meaning (via cognitive schema) is designed, its hints solicited.

If this analysis has merit, it suggests that a CAG 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 $N \dashrightarrow N$ or $N^{+} \dashrightarrow N^{+}$; but, in more detail, it adds a kind of cognitive rider attached to the mapping which focuses cognition in the

[5] A note on notation: I adopt the Haskell convention (referring to the Haskell programming language and other functional languages) of using arrows both between parameters and before output notation, but for visual cue I add one dot above the arrow in the former case, and two dots in the latter: $Arg_0 \dashrightarrow Arg_1 \rightarrow \cdots \dashrightarrow Result$. I use N for the broadest designation of nouns (the broadest noun type, assuming we are using type-theoretic principles), with extra markings for more specific types (in principle similar notation could be adopted for verbs, propositions, and so on).

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 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. It would be an argument in favor of Dependency Grammar if Dependency-oriented representational models, like Link Grammar, prove to be especially adept in this modeling.

In this analysis, I am already switching to functional and type notions that will be discussed in greater detail below; my current emphasis is on link grammar as a syntactic conception, although I have also tried to argue that separating syntax from semantics can be at most provisional. Inter-word "link pairs" are vehicles for expressing syntactic rules (like singular/plural agreement) but are also a ground level for semantic analysis, since we can explain how semantic nuances are carried, in specific sentences, by the actual link-pairs in evidence (violations to agreement norms, for example). These semantic nuances in turn can be given cognitive interpretations, revealing the syntax-semantics-cognition pattern which I am sketching here through specific perspectives like Link Grammar and Type Theory. Returning to the initial grammatic stage of analysis, however, my tactics for contrasting overall Dependency and Phrase-Structure paradigms rest on an implicit picture of how theories should be evaluated. While such a picture is probably fairly consistent across perspectives, it is still worth making a little more explicit.

5.2 *Explanation and Formality*

Both Dependency and Phrase Structure grammars presuppose that the fundamental exposition and achievement of their theory involves formal transformation of linguistic givens, resulting in a more complex data structure which, to the extent that the theory is correct and useful, models something of the inner structure of language (*qua* abstract formal system and/or cognitive phenomenon). The "data structure" might be a phrase-structure "tree" or a graph-like dependency "linkage", but while these representations have different form they share certain criteria: they are formally describable systems which allow some structures but reject others; they are rigorous enough to be given a mathematical (e.g., algebraic) definition; and they can be expressed in computer code which builds these structures out of Natural Language artifacts, can verify that an instance of the relevant data structures satisfies the system rules, and can execute operations which modify the structures. The phrase trees or word-link graphs are "formal substrata" which encapsulate Natural Language patterns but also are rigidly mathematical and computational. How thoroughly these substrata capture linguistic meaning, is therefore directly relevant to questions of whether and in what degree natural language itself, as social and cognitive, is also formal and computational.

Translating NL content into (say) a linked-grammar graph does not make software capable of "understanding" language. If Dependency Grammar is a reasonable foundation for linguistics in general, then properly parsing sentences into their auxiliary graphs is, at most, a step in the direction toward "understanding". Even this may beg the question of what constitutes a "correct" parse: when writing real-world code, language engineers appear to rely principally on their own intuitions, based on their familiarity with the underlying theory, the idea they have of what a *correct* "re-presentation" looks like (for link grammar, of the correct collection of link types between the various words). They then add code to ensure that this representation is indeed identified by the software in specific examples, and try to do so in such a way as to generalize to other examples. This methodology can be gleaned from observing internet chat sites and other informal research venues; one can witness developers painstakingly constructing systems which "work right" in the sense of producing the interpretation for each sentence which corresponds with what the human linguists perceive, even for sentences which the software has never encountered before. The code is considered reliable the more that new sentences are "correctly" parsed. Again, "correctly" here means,

conformant to linguists' own interpretations; insofar as these are subjective, such conformance is not conclusive evidence that the transformational algorithms are "correct".

In order to assess linguistic "competence" (or whatever computational ability may simulate it), it is needed to check specific "behavior" and compare it to some expectation. The gold standard for linguistic behavior is just participating in a linguistic community, judged by the community at large as fully competent and included. Unfortunately, however — at least for those who want to profit from Artificial Intelligence — achieving true "language-like behavior" may be impossible. Scholarship therefore has to turn toward more limited notions of competence, such as representational transformation of sentences — but since each theory has its own picture of what sentences should be transformed *into*, the justification of competence measures can be circular. It is the theory which dictates how the software should act, and the software is deemed "intelligent" if it acts accordingly. We can be skeptical of such non-theory-neutral conceptions of "intelligence". Nonetheless it does count in theories' favor if they both propose accounts of language structure which are independently defensible and also can produce computing systems that reliably and without external direction map language onto those structures. Language-like behavior then involves producing a transformed representation of language embodying a particular theoretical conception of linguistic "deep structure".

It would serve Computational-Linguistic theories still further to create systems that demonstrate behavior which is "language-like" on terms less wedded to their own hypotheses. More satisfying definitions of linguistic behavior would involve intuitions of language users in general, not just language experts. For example, document classifiers — which typically use statistical analysis to predict which topic will be deemed most relevant for documents like news stories and technical articles — again illustate a kind of transformational representation, converting Natural Language to a formal data structure (in this case a relatively simple one, naming one or multiple topics from a predefined list). In this case however a broad user public can provide feedback on how well the system performs. For another example, artificial translators map language onto formal structures but then attempt an opposite map, translating the formalized representation into natural-seeming expressions in a different language. This case is different in that formal representation is an intermediary rather than end point of the transformation, but like document classifiers it is a kind of behavior whose effectiveness can be judged by a large community of speakers. People who interact with text "chat" bots, or talking robots, and feel that the experience is similar to talking with another person, are also providing evidence of more complete and larger-scale language-like behavior. Again, though, it is not now and may never be possible to engineer intelligent behavior to this level of perfection. Existing language AI platforms are flawed but useful, which suggests both that formal re-presentation is an important step toward language understanding but also that attempts to use these formalisms as a springboard to more holistic behavior — like automated translation, but also extracting practical information, or gleaning emotion and sentiment — are missing something essential. Doing useful things with or gleaning useful insight from the re-presentational target structures appears to be a separate problem from that of generating them — which calls into question the degree to which the target structures sufficiently encapsulate linguistic meaning, even if they reveal structures which are essential to linguistic meaning.

This does not have to mean that Natural Language Processing is basically impossible, only that more modest criteria of "correct" NLP systems need to be adopted. This is complicated by the fact that artifical language behavior can be flawed but meaningful: "Urine shift one step forward" is an awkward English sentence but its meaning seems clear enough (this real example comes from a shopping center in New York's Flushing, Queens Chinatown). We have an intuition that some expressions are "incorrect" but not so completely off-base that they fail to signify anything at all — but in this case we need criteria for how a linguistic performance can be both incorrect *and* nonetheless coherent.

These issues influence any theory which approaches linguistic competence from the viewpoint of formal representations, and therefore effectively all branches of Computational Linguistics. The reigning assumption appears to be that transformational representation which converts language to theory-regulated data structures, for which in many cases the transformation achieved by

mechanical algorithms matches that intuited as most accurate by human experts, serves as *prima facie* evidence of something like computationally-engineered "intelligent (language) behavior". This leaves room for language-like behavior to productively replicate dimensions of language understanding while also being very incomplete: language-like relative to experts' opinions on deep linguistic structure, not real-world communication. Structures like link grammar graphs can be essential formal substrata that linguistic expression relies on to achieve communication, without being the sole medium of this expression.

My arguments so far have used Link Grammar as a representative example of "transformational representation" where a computational system can be judged to reveal some level of language competence, some kind of "language like behavior", insofar as it translates natural language expressions to data structures conformant to Dependency Grammar (and particularly Link Grammar) theory. As I also just argued, performance vis-à-vis structural transformation may be only tangential to human language, so whatever theory is built up needs a separate, more philosophical or metatheoretical analysis to consider how the theory is purported to engage with its phenomena. But I now take this as a starting point for pivoting the discussion from grammar to semantics; and will defer until after that speculating on philosophical implications of the theory thus extended.

6 Link Grammar and Type Theoretic Semantics

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?

To explore these questions it is first necessary to consider how a grammar theory can be extended to and/or connected with a formal or, to some measure, informal semantics. Here I will present one approach to make this extension vis-à-vis Link Grammar.

Insofar as grammatic categories do provide a very basic "Ontological" viewpoint, it is reasonable to build semantic formalization on top of grammar theories. Link Grammar, for example, explicitly derives "link types" — species of word-to-word relations — by appeal to "Categorial" grammars which define parts of speech in terms of their manner of composition with other, more "fundamental" parts of speech [33], [56], [42]. The most primordial grammatic categories are generally seen to be nouns and "propositions" (self-contained sentences or sentence-parts which assert individual states of affairs), and categories like verbs and adjectives are derived on their basis. For example, a verb "combines" with a noun to produce a proposition. *Students* is an abstract concept; "Students complained", tieing the noun to a verb, tethers the concept to an assertorial flesh, yielding something that expresses a belief or observation. Meanwhile, Categorial Grammar models not only the semantic transition from abstract to concrete, but surface-level composition: in English and other SVO language for example the verb should immediately follow the noun;

in German and all SVO languages the verb tends the come last in a sentence, and can be well apart from its subject. The semantic pattern in the link is how the verb/noun pair yields a new semantic category (propositional) whereas the grammatic component lies in how the link is established relative to other words (to the left and not the right, for example, and whether or not the words are adjacent).

Assuming that surface-level details can be treated as grammar rules and abstracted from the semantics, we can set aside Categorial Grammar notions like connecting "left" vs. "right" or "adjacent" (near) vs. "nonadjacent" (far). With this abstracting, Categorial Grammar becomes similar to a Type-Theoretic Semantics which recognizes, in Natural Language, operational patterns that are formally studied in mathematics and computer science [40], [41], [40], [54], [43]. A verb, for example, *transforms* a noun into a sentence or proposition (at least an intransitive verb; other kinds of verbs may require two, or even three nouns). In some schematic sense a verb is analogous to a mathematical "function", which "takes" one or more nouns and "yields" propositions, much like the "square" function takes a real number and yields a non-negative real number. To make this analogy useful, however, it is necessary to clarify how "types" in a mathematical or computational context may serve as appropriate metaphors for syntactic and/or semantic groupings in language.

6.1 *Types, Sets, and Concepts*

Most Computer Science rests on types rather than (for example) sets, because abstract reasoning about data types requires some abstraction from practical limitations about how particular values may be digitally encoded. Types can be defined as sets of both values and "expectations" [10] (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 type-space and can be the basis of topological or Category-Theoretic rather than set-based analyses of type-extension. Also, expectations intrinsically include functions which may be "called on" types. 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. 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 will briefly argue later, 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; this reasoning arguably carries over to types as well. Also, sometimes the clearest "representative" example of a type or concept is actually not a *typical* example: a sample latter 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. Computer Science develops other pictures of types' "state space", reflecting the trajectory of symbols or channels which hold type instances, which at different moments in time become initialized — acquiring a value obtained from a *constructor* function (one "type space region" is then demarcated by which values can be direct results of constructors) — then possibly subject to change in the value they hold, and finally (often) transitioning to a state where the held value is no longer "valid".[6] Type *spaces* have potentially complex patterns of regions and equivalence classes of inter-value mappings (in the sense of behavioral equivalence relative to code analysis, testing, or security) — the *conceptual* properties of types are expressed in the *internal structuration* of their associated state-space. Putting this in mathematical language, an

[6] Managing the "lifetime" of values from many types, especially "pointer" types (that hold a numeric value representing the current memory address of some other value), has been a notorious source of programming errors, especially in older computer languages. Of late, also, data types often need to be designed to minimize the risk of data corruption, theft, and malicious code. For these reasons, Cybersecurity takes particularly interest in studying types' extensions and transitions between different values (morphisms within a type space) to formally describe states or state-transitions which are security vulnerable.

in-depth treatment of types cannot work "in the Category" of sets, even for basic type-extension, but rather (for instance) the Category of Topological Spaces.

Moreover, 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. A value representing someone's age may be assigned a type for which a legal value is, say, 1000 years, which is obviously unreasonable — the conceptual role served by the *particular* use of a type in some context can be distinct from the entire space of values exhibited by the type. It is possible to construct types which are narrowed down to more precise ranges, but in many cases this is unnecessary or poorly motivated: while 1000 years is clearly too large for an age, it would be arbitrary to specify a "maximum allowed" age (recall that assuming a "maximum allowed" year of 1999 — so that the year in decimal only required two digits — led to costly reprogramming of archaic legacy code during Y2K). In this kind of situation programmers usually assign types based on properties of binary representation — what number of binary digits is optimal for memory and/or speed, even if this allows "absurd" values like 1000 years old. Run-time checks, rather than type restrictions, may be used to flag nonsensical data and prevent data corruption. In these scenarios, types represent a compromise between *concepts*, which can be fuzzy and open-ended, and *sets*, which conceptually are nothing more than the totality of their extension.[7]

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 classical interdependence of sets, logic, and mathematics.[8] 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 langauge.

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 ([37, p. 18]; [30, p. 171, or p. *xi*]) and embodied/enactive patterns of interaction ([37, p. 90]; [30, 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 struture.

[7] Nevertheless, there is interesting (and potentially practically useful) research in how formal type-constructions model conceptual organization: for example, Gärdenfors Conceptual Space Theory has seen formal implementations [1], and it is very interesting to juztapose scientific and mathematical treatments of Conceptual Spaces (as in [66] or [24]) with mathematical (e.g., topological) thoeries of data types [21], [57].

[8] Recent work in mathematics, however (partly under the influence of computational proof engines and foundations research like Homotopy Type Theory) shows that type and/or Category theory may replace sets as a groundlevel for logico-mathematical reasoning (if not notation) in the future [29] (It is worth pointing out that despite their similar ordinary meanings, mathematically *type* is much different from *Category* even though these respective theories can be usefully integrated).

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 [79], [5], [77]. 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 these sentences:

- Tigers in that park are threatened by poachers.
- Young tigers are threatened by poachers.

Both sentences focus a conceptual lens in greater detail than *tiger* 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 tigers", in the sense of *existing* tigers, 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.

There is a type-theoretic correspondence between intension and extension — for a type $\mathcal{T}$ there is a corresponding "higher-order" type of *sets* whose members are $\mathcal{T}$.[9] 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. "Tiger" does not mean *all tigers* (or *all possible tigers*) — though arguably there are concepts *all tigers* and *all restaurants* (etc.) along with the concepts *tiger* and *restaurant*. 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, 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 in-

[9] Related constructions are the type of *ordered sequences* of $\mathcal{T}$; unordered collections of $\mathcal{T}$ allowing repetition; and stacks, queus, and deques (double-ended queues) as $\mathcal{T}$-lists that can grow or shrink at their beginning and/or end.

stances' 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 ("Let's find a restaurant that's family-friendly"; allowing such one-off narrowing is a feature of the concept's flexibility). 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 spaces 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 airborn 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.[10] Accordant variations of cognitive 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. *Conceptual* is more abstract and belief-oriented; *Cognitive* is more concrete and phenomenological. Concepts organize our "background knowledge" [64]; cognitions allow it to be latent against the disclosures of material consciousness [62], [63], [80], [31]. 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).[11] 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 "tiger" means the concept *tiger* ("type" in the sense that type-theoretic semantics would model lexical data ac-

[10] People, 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", even if we are nearby an airport. Were "flying people" used jokingly, it would be in bad taste, like "cat all over all over the driveway" from Pinker [52] on page 119 and Langacker's "Nouns and Verbs" [38] on page 67.

[11] We 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?

cording to type-theoretic rules, such as *tiger* 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 these from a conceptual matrix. On this basis, we can argue that these schema 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, as a bus carries people into a city. "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 benefactive case as a case study (no pun intended), consider how an ontology of word senses (which could plausibly be expressed by types and subtypes) 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:

- (115) I got glue for your daughter.
- (116) 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 benefactive case along with notions of classification, on the grammar/semantic border, that have a potential type-theoretic treatment. It is easy to design similar examples with other cases: a locative construction rarely targets "sentient" nouns, so in

- (117) We're going to Grandma!
- (118) Let's go to him right now.
- (119) Let's go to the lawyers.
- (120) 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 (simplistically) meet the expected interpretation as "designation of place". We need to analyze syntactic details like noun case and forms of articles, but also finer-grained (though not purely lexicosemantic) classifications like sentient/nonsentient or spatial/institutional.

One way to engage in classification in this kind of example is just to consider subtyping: divide nouns into sentient and non-sentient, the former into human and animal and the latter into artifacts and natural things, and so forth. But other options are less blunt. For example, notions like sentient/nonsentient can be construed as "higher-order types", meaning that for broadly-hewed types like nouns or verbs, there are sentient (and non-sentient) variants, just as for a type $\mathcal{T}$ there are mass-plural and count-plural collections of $\mathcal{T}$, ordered and unordered $\mathcal{T}$ collections, and so on. Subtyping, higher-order types, inter-type associations and various other formal combinations are options for encoding grammatic and semantic classification in something like a formal type theory. The key properties of type systems are not only meanings atttached to individual types but notions of functionality (according to the central notion that a type system includes "function" types which are mappings between other types; in Category Theory, any formal type system is "Cartesian Closed", meaning that if $\mathcal{T}_1$ and $\mathcal{T}_2$ are types, there is necessarily a type $\mathcal{T}_2^{\mathcal{T}_1}$ of functions between them). So if adjectives, say, are most basically $N \dashrightarrow N$ (they modify nouns and yield noun-role phrases), we can then consider how adjectives should be modeled when their modified nouns are associated with or attributed sentience, mass-plural, or any other variation (whether via subtyping or some other association). How these "variations" are modeled in accord with one single type is less important than how they "propagate" via applicative structures, where "function-like" types apply transformations and produce phrases.

To build up a linguistic type theory, I assume, then, a framework of types and type associations with a few underlying properties, such as these:

- Types have a spectrum of granularity, from the very broad (Parts of Speech) to the much narrower, including (at the fine end of the scale) where they incorporate lexical data (types can potentially include *tiger*, *house*, and so on). In between are constructions related to "Ontology", like sentient/nonsentient, pointwise/extended, artifact/institution, among many others.

- Types are neither strictly grammatic nor strictly semantic, but their gradations of precision cross between grammar and semantics.

- Returning to "Ontology": types have associated qualities like sentient/nonsentient; spatially (and/or temporally) extended, pointwise, or non-spatial (/non-temporal); caused, self-causing, self-determining, affected by other things, affecting other things; objects, events, processes, or institutions; abstracta or spatetime present things; observables or subjectives like emotions or sensations, which are temporally present for someone but not (directly) encountered by others. These are qualities pertaining to the manner of referents' appearing, causing, and extending in the world and in consciousness, and to a "classification" of kinds of entities (like a metaphysical Ontology, though the point is not to reproduce Medieval philosophy but, more modestly, to catalog word senses). I will refer to these qualities generically as "associations". They may be introduced via subtyping or more complex type operators.

- Some types are "function like": this means that they are *applied* to senses which have their own types. This introduces one form of head/dependent relation, where a head word instances a function-like type and is applied to one or more "dependents".

- Type information "distributes over" Link Grammar pairs. For any pair of words which have a meaningful inter-word relation, we can consider types which may be applicable to both words, and how these types affect and are affected by the significance of the particular kind of link. Some kinds of links mandate particular type interpretations of the links elements: TS links,[12] to cite a narrow example, would only be formed between verb and $\mathcal{P}rop$ types (at least this is a plausible interpretation of the relevant Link

[12] http://www.link.cs.cmu.edu/link/dict/section-TS.html

Grammar rules. Other type/link combinations are more open-ended.

- Type information similarly "distributes" over clusters of link-pairs, where the presence of one such link influences how a connected link is understood (or whether it is allowed). Type-related qualifications can propagate from one link-pair to connected link-pairs.[13]

- Type information also "distributes over" applicative structures. Given a function-like type we can consider how associations for the head and dependent elements propagate to associations on the resulting phrase — again, via subtyping or some other mechanism.

Such a "linguistic type theory" needs to model (at the least) these aforementioned associations, the "distribution" of type details over link and applicative structures, and the "propagation" of associations and other type details. While informal analyses in any single case may be clear, integrating many case-studies into a unified theory can be advanced by drawing ideas from rigorous, quasi-mathematical type theories — relevant research has adopted technical formations like "dot-types", higher-order types, dependent types, Monoidal Categories, Tensors, Continuations, "Linguistic Side Effects", Monads, Combinatory Logic, and (Mereo)Topology/Geometry.[14] Such techniques can marshal type-theoretic ideas without falling back on simplistic type notions that can end up collapsing a type-system into a one-dimensional "Ontological" classification, rather than exploring more advanced formulations like higher-order types and (what I am callling) "associations".

With respect to Type Theory related to Link Grammar, consider again the TS links (there are dozens of potential link-grammar pairs, of which TS are among the less common, but they provide a useful example). First, note that $\mathcal{P}rop$ provides a type attribution for sentences, but also for sentence parts: *he is at school*, for example, presents a complete idea, either as its own sentence or part of a larger one. In the latter case, a $\mathcal{P}rop$ phrase would typically be preceded with a word like *that*; in the case of Link Grammar, we can define words relative to their semantic and/or syntactic role, which often lies primarily in linking with other parts of a sentence or helping those parts link with each other. Type-theoretically, however, we may want to assign types to every word, even those which seem auxiliary and lacking much or any semantic content of their own. Arguably, *that* serves to "package" an assertion, encapsulating a proposition as a presumed fact designated as one idea, for the sake of making further comments, as if "making a noun" out of it: $\mathcal{P}rop \dashrightarrow N$. Perhaps our intuitions are more as if *that he is at school* is also a proposition, maybe a subtly different kind, by analogy to how questions and commands are also potentially $\mathcal{P}rop$ variants. Since THAT-phrases are "arguments" for verbs, the choice then becomes whether it is useful to expand our type picture of verbs so that they may act on propositions as well as nouns, or rather type "encapsulated" propositions as just nouns (maybe special kinds of nouns).

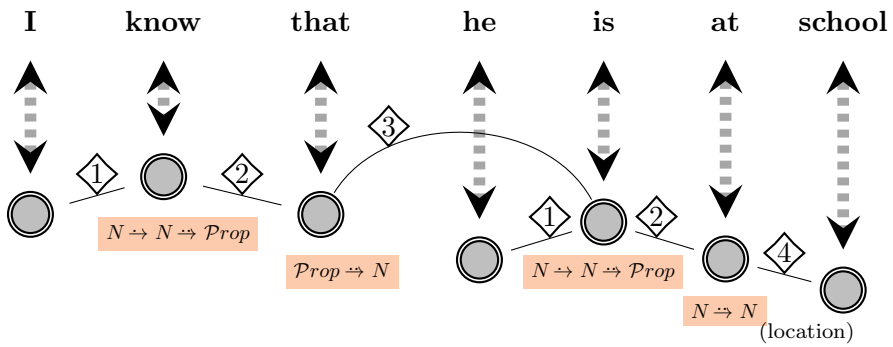
In either case, *I know that ...* clearly involves a verb with subject and direct object: so either $V :: N \dashrightarrow N \dashrightarrow \mathcal{P}rop$ or $V :: N \dashrightarrow \mathcal{P}rop \dashrightarrow \mathcal{P}rop$. Consider the role of a TS-link here: specifically, TS connects the verb to the assertorial direct object (most directly, to *that*). The purely formal consideration is ensuring that types are consistent: either the TS target is $\mathcal{P}rop$, as I suggested above, with the verb type modified accordingly; or the TS target is a noun, though here it is fair to narrow scope. For this particular kind of link, the target must express a proposition: either typed directly as such or typed as, say, a noun "packaging" a proposition, which would then be a higher-order type relation (just as "redness" is a noun "packaging" an adjective, or "running" is an adjective packaging a verb). In other words, it is difficult to state the type restrictions on the link-pair without employing more complex or higher-order type formations.

On the other hand, this is another example of the fuzzy boundary between syntax and semantics: given a sentence which seems to link a verb calling for a belief or assertion (like "know", "think", "suggest", "to be glad")

[13] For example, we can say that the linkage structure in "Three times students asked an interesting question" alters the normal type-attribution of "students" as just a plural noun; relative to the connected structure linking "three times" through "students" to "a question", we can say that *three times* modifies "students" so that it may function, as subject of "asked", as if typed as singular, because *three times* acts as a "space builder" and creates a mental frame wherein the students are singular, even if the word is plural. Because of this frame phenomenon, the singular/plural status of students does not propagate to "a question"; collectively they presumably did not all ask just one question. Type annotation for "students" has to be defined, in this case, relative to multiple "cognitive frames".

[14] Monoids: [19]; Tensors: [41]; Continuations: [4]; Combinators: [73]; Side Effects: [59]; Monads: [25], [58], [33]; Topology: [51], [13].

Figure 2: Dependency-style graph with type annotations



- 1 Verb's subject argument
- 2 Verb's direct object argument
- 3 Propositional "packaging" ("typed" as $\mathcal{P}rop \dashrightarrow N$)
- 4 Locative auxiliary link
  (may be typed as converting nouns to place-designations)

to something that is not proposition-like, is such a configuration ungrammatical, or just hard to understand? Clearly, the *semantic* norms around verbs like "know" is that their *subject* has some quality of sentience (or can be meaningfully attributed belief-states, even if speakers know not to take it literally: "The function doesn't know that this number will never be zero"); and their *object* should be somehow propositional. But applying type theory (or type theory in conjunction with Dependency Grammar) leaves open various analytic preferences: these requirements can be presented as rigid grammatic rules or as "post-parsing" semantic regulations. How to model the qualities of sentience (or at least of having propositional attitudes broadly conceived), for the noun, and of propositionality, for the direct object, are again at the discretion of the analysis (subtypes, quality-associations, or etc.) — Figure 2 shows one potential, rather simplified unpacking of the sentence; from this structure details can be added perhaps as extra syntax constraints or perhaps more as cues to interpretation. If these requirements are seen as more syntactic, so qualities are incorporated into data like Part of Speech (say, a noun designating something with propositional attitudes being a subtype of of a generic N type), then we are more likely to analyze violations as simply incorrect (recall "The tree wants to run away from the dog" — ungrammatical or just somehow "exotic"?). Some examples suggest less incorrectness as clever or poetic usage — so a richer analysis may recognize expressions as type- and link-wise acceptable, but showing incongruities (which is not the same as impropriety) at a more fine-grained type level. That *to want* takes a subject *associated* with sentience does not force type annotations to inscribe this in grammatic or lexical laws; instead, these associations can be introduced as potential "side effects", *triggering* re-associations such as forcing hearers to ascribe sentience to something (like a tree) where such ascription is not instinctive. The type effect in this case lies more at the conceptual level, the language-user sifting conceptual backgrounds to find a configuration proper to the type requirements (in what sense can a tree "want" something?). In this "tree" case we probably appeal to concepts of "as if": if the tree *were* sentient, it would be nervous of the dog sniffing around — a humorous way of calling attention to the dog's actions (obliquely maybe alluding to people's background knowledge that dogs sometimes do things, like pee, in inconvenient places, from humans' perspectives).

In brief, it is certainly possible — though by no means mandatory — to model type requirements with greater flexibility at a provisional grammatical layer, and then narrow in on subtypes or extra accumulations of qualifications on type-instances in a transition from grammar to semantics. Perhaps cognitive schema occupy an intermediary role: progressing from basic recognition of grammaticality, through cognitive schema, to conceptual framing, with type machinery capturing some of the

thought-processes at each "step" (not that such "steps" are necessarily in a temporal sequence). The basic verb-subject-direct object articulation sets up an underlying cognitive attitude (represented by a basic type-framing of verb, noun, and proposition, like the $V :: N \dashrightarrow N \dashrightarrow \mathcal{P}rop$ signature). Cognitive ascriptions fill this out by adding detail to the broader-hewed typing, associating sentience with the subject and propositionality with the object (sub- or higher-order typing modeling this stage). And how the actual lexical choices fit these cognitive expectations — I call them cognitive because they are intrinsically tied to structurational schema in the type, morphology, and word-order givens in the encountered language — compels conversants to dip into background beliefs, finding concepts for the signified meanings that hew to the intermediary cognitive manipulations (finding ways to conceptualize the subject as sentient, for example). This also has a potential type model, perhaps as forcing a type conversion from a lexical element which does not ordinarily fit the required framing (such as giving inanimate things some fashion of sentience). Type theory can give a window onto unfolding intellection at these multiple stages, although we need not conclude that the mind subconsciously doing this thinking mimics a computer that churns through type transformations mechanically and exactly.

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. Stuctural 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 disputatable claims about how language and congition works. In that spirit, then, I will try to condense the three "layers" of unfolding understanding, which as I have sketched them are posited in the metaphysical order of temporal experience — "unfolding" in likely overlapping, blending ways — I will "read into" them a more static and logically stacked meta-structure. Where I have sketched three layers or stages of unfolding language understanding, I will transition to proposing three "tiers" of language organization, in particular three levels where type-theoretic models can be applied.

6.2 *Three tiers of linguistic type theory*

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. Type-related observations can be grouped (not necessarily exclusively or exhaustively) into those I will call *functional* — relating mostly to Parts of Speech and the functional treatment of phrases as applicative structures; *Ontological* — engaged with existential/experiential qualities like sentient/nonsentient, rigid/nonrigid, and others I have discussed; and *Lexical* — related to lexemes and word-senses. The 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.[15] 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

[15] So, conceiving microclasses similar in spirit to Steven Pinker in Chapter 2 of [52], though I'm not committing to using the term only in the way Pinker uses it. Cf. also [72], which combines a microclass theory I find reminiscent of *The Stuff of Thought* with formal strategies like Unification Grammar.

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:[16]

- (121) The newspaper you are reading is being sued.
- (122) 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 — *the newspaper fired the reporter and fell off the table*; *Liverpool beat Chelesea and built new docks* (again, slightly modifying the counter-examples). Type coercions are *possible* but not *inevitable*. Certain 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 (*Liverpool wants to sign a talented young striker*). 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 meeeting 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

[16] [15, p. 40] (former) and [43, p. 4] (latter).

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 *functional* type 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 grammatic level, to which I now turn, 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 grammatic configuration appears to hold, in the present langauge 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 $\mathcal{P}rop \dashrightarrow N \twoheadrightarrow N$ taking the place of gravitational equations; and sentences' grammatic spine taking the place of curvature pulling mass into a planetary center.

Parts of speech 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 I have been notatating with something like $N \dashrightarrow N \dashrightarrow \mathcal{P}rop$. At the most basic level, the relation of Parts of Speech to "type signatures" seems little more than notational variants of conventional linguistic wisdom like a sentence requiring a noun 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 link and phrase structures can be complex. Even the most broadly scoped analysis of type signatures, dealing only with generic Parts of Speech like nouns and verbs, can lead to surprising complications. One example I have alluded to several times, and will return to shortly: the problem of applying Dependency Grammar where phrases do not seem to have an obviously "most significant" word for linkage with other phrases.

A tendency in both dependency and phrase-oriented perspectives is to define structures around the most "semantically significant" words — so that a phrase like "many students" becomes in some sense collapsible to its semantic core, "students". Some of my earlier examples, however, argued that phrases cannot just be studied as replacements for semantic units. Incorporating type theory, we can instead model 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 $\mathcal{P}rop$ and the rest of a tree is formally a reducible structure in Typed Lambda Calculus: $N \dashrightarrow N \dashrightarrow \mathcal{P}rop$ "collapses" to $\mathcal{P}rop$, $\mathcal{P}rop \dashrightarrow N$ 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 $\mathcal{P}rop$ 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 $N \dashrightarrow N$ yields the N as second argument for *is*, which in turn yields a $\mathcal{P}rop$ 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'. Phrases are modeled via a "function-like" Part 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 (this is an example of embedding lambda calculii in process algebras), so a type-summary of a sentence's phrase structure can be notated and analyzed without leaving the Link Grammar paradigm.

As a concrete example, in the case of "many students", both "students" and the semantic role of the phrase are nouns (count-plural nouns, for where that's relevant). Accordingly, "many" has a signature $N \dashrightarrow N$ (or $N^{+} \dashrightarrow N^{+}$, dependending on how narrowly we want to notate the types in context). Once we assign types and signatures to all words in a sentence, we can also see a natural hierarchy resembling an expression in typed lambda calculus, where some words appear as "functions" and others as "arguments". Often the less semantically significant words appear as "higher" in the structure, because they serve to modify and lend detail to more significant words. The kind of structure or "Charpente" which falls out of a sentence — adopting a term from Tesnière (cf. [69, p. 181]) — is typically different from a link-grammar "linkage", although the two structures can be usefully combined.

To return to the example of "Student after student", where designating one word to "represent" the phrase seemed arbitrary, we can analyze the situation via type-signatures. I have teased a proposed solution repeatedly; here's what I had in mind. Insofar as *after* is the only non-noun, the natural conclusion is that "after" should be typed $N \dashrightarrow N \dashrightarrow N$ (which implies that "after" is analogous to the "functional" position, and in a lambda-calculus style reconstruction would be considered the "head" — Figure 1 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*), which can be accommodated by invoking the (computationally rather complex and topical) concept of *dependent types* [7], [68] — in other words the parameters for *after* are a dependent type pair satisfied by an identity comparison between the two nouns. The signature for "after" has this added complication, but the nuances of this example can still be accommodated within the overall architecture of type theory. I would pair this argument with my earlier analysis of "many" variations which suggested how apparent complications can be accommodated largely within the extant theoretical resources of Link Grammar, and in combination suggest that the union of Link Grammar with Type-Theoretic Semantics seems poised to accommodate many complex real-world linguistic cases with a coherent abstract perspective.

Consider alternatives for "many students". The phrase as written suggests a type signature (with "many" as the "function-like" or derivative type) $N^{+} \dashrightarrow N^{+}$, 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 $N^{+} \dashrightarrow N^{+}$ 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 (a similar dynamic applies to the idiomatic "come out" to mean, for someone gay or lesbian, "come out of the closet" — in that idiom the spatial figure is explicit but metaphorical). 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 there sustains a chance that this undercurrent will actually figure in conversants' mutual understanding — if there were not just columns being written and opinions voiced but demonstrations on the quad. The spatial undercurrent is poised to emerge as more literal, should the context warrant. However literally or metaphorically the "space" of the cognitive "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.

6.3 *Levels of formalization*

Of the three type levels I have proposed, the "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 people 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 argumentational, 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?

Computer languages are a good case-study in what I might call "semiotic computability". This designates the question of whether the operations of sign-systems — how sign-users express intentions by forming or modifying structured networks of signs that explicitly exhibit or are understood to have been formed according to collectively recognized signifying rules — can be modeled, at least to some substantial degree, by computable algorithms. Our notion of computation can be based on modern computer code, not just academic topics like pure functions: the behavior of computing systems where many functions run concurrently, with possible side-effects, is often non-computable via static analysis; such systems can only be understood by actually running them. Nevertheless the capabilities of software

programmed in modern languages certainly deserve to be characterized as "computable" behaviors. A single function, which embodies a computable calculation, may be part of a process space whose evolution through time is nondeterministic, and computing environments which employ functional side-effects are difficult or impossible to evaluate in the abstract. I use "computability" therefore in this wider sense: operationally implementable according to theories underlying mainstream programming languages, which is conceptually (if perhaps not mathematically) distinct from "computability" in subjects like algorithm analysis.

Natural Langauge Processing, working with human languages from a computing platform, is then a step further, continuing beyond logico-mathematic abstractions and toward empirical language-use. We can consider at what point formal and computational methods reach a limit, beyond which they fail to capture the richess 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. Using the wording I just proposed, we can speculate on whether all language is "semiotically computable" or whether language merely depends on faculties which in some neurological and/or presentational sense are "computable" in those terms — faculties that, measured against linguistic fluency, are necessary but not sufficient. Whatever one's beliefs on this last question, a progression of subdisciplines — from formal-logical semantics through programming langauges and computational Natural Langauge 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 sketched a similar theoretical progression, starting with a theory of grammar (Link Grammar), transitioning to a form of semantics (a type-theoretic semantics defining type hierarchies and signatures over linkage graphs), and finally proposing a cognitive interpretation of the resulting semantics. I will refer to this *interpretation* as "Cognitive State Semantics", meaning that such a theory adopts its *formal* structures from Link Grammar and type-theory but also attempts to *motivate* these structures by appeal to cognitive considerations. Both Link Grammar (through its specific Category of labeled graphs modeling sentence linkage-structures) and Type-Theoretic Semantics work with rigorous, algebraically formal models satisfying criteria I referenced at the end of the last section: translation of language content into these formats and subsequent review or transformation of the target structures can be programmed as a purely mechnical space of operations.

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 non-computable: I would work on the assumption that language *as a whole* and as human social phenomena is not "computable" in a semiotic sense, or any related practical sense (although I make no metaphysical claims about the "abstract" computability of mental processes merely by virtue of their neurophysical materiality). The aforementioned "linguistic side effects" can be *modeled* by tracing our reception of linguistic meaning through syntactic and semantic formations, like Link 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, $N^{\odot} \dashrightarrow N^{+}$-pattern phrases. The important balance is to take formalization as far as is reasonable without being seduced into logico-symbolic reductionism — a methodological pas de deux I will explore further in the next, concluding section.

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 differentiation [17] : *baked*, not *made*; *flew*, not *traveled*; *spill*, not *pour*. These undercurrents 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 possibilia.

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 $N \dashrightarrow N$ 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 $N \dashrightarrow N^{+}$ or $N^{+} \dashrightarrow N^{+}$. 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).

Given these considerations, I propose a "Cognitive State Semantics" — understanding phrase structure in terms of (or analogous to) functional effects (like [59]), but cognitive: word and syntax choice effectually steering cognitive appraisals of jointly experienced situations in specific directions. Cognitive State Semantics also has formal implications: the inner structuration of data "spaces", including unknown and undefined values, and including (side-effects-bearing) function types, can be understood as dynamic *states of knowledge* and their changes, grounding datatype semantics in human use/interactions. Linguistically, the "effects" of language

[17] Alluding, in part, to Sausurrean "system of differences" [49, p. 15] — to choose a reference which introduces Sausurre in a rather unexpected context.

"functions" are mutations/modifications in cognitive state, respondant 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.

7 Conclusion

Without reducing linguistic *performance* to language qua field of propositional expression, and without collapsing linguistic meaning to a computable/propositional fragment, we can still allow interpretive-Phenomenological and formal/mathematical perspectives to co-exist. In the theory I have sketched, Cognitive Schema summarize lived, situated judgments and intentions that (in concrete form) are not "computable" (again with the caveat that our mostly science-driven worldview may imply that all reality is "computable" in some infinitely-powerful computation; I understand "computability" to terminologically exclude such a purely speculative level of capacity). However, our propensity to call up certain construals rather than others is triggered by linguistic formations, and in broad outline the catalog of these triggers, and their compositional structure, can be formalized (and even used to improve formal systems, like programming languages). The challenge is to advocate for this co-existence without implying that formal systems, and mathematically provable system-properties, are the only kind of research tools which have scientific merit.

Subjective assessments are intrinsic to most linguists' argumentation — warranting claims not with empirical data or logico-mathematical proof but by appealing to speakers' intuitions, so that reading linguistic texts is also collaborating on an ongoing research project (partly because language evolves, so word-meanings change, and formations which are ungrammatical for one generation may be experienced differently by others). Nevertheless, linguistics, like economics, seems broadly accepted as a human *science*, not just an interpretive discipline. The claim that an economist's equation or a linguist's meta-grammar are accurate explanations, useful explanatory frameworks, seems generally evaluated in terms of whether their framework captures emergent higher-order structure, and offers an explanatory potential that does not merely reiterate lower-scale paradigms. A theory expressed in the language of linguistics (not, say, neural networks), if it meets general criteria of testability and refutability (not necessarily empiricist/quantitative), arguably carries even more weight than lower-level neurophysical explanation — precisely because the higher-scale "theory language" carries the burden of explaining emergent properties, which as *emergent* bear some descriptive/behavioral (if not causal) autonomy. Likewise, a subjectively plausible and theoretically motivated equation which fits economic data probably carries more weight than a mere statistical analysis. An explanatory focus on the higher-scale in terms of its own distinct (emergent) structures and theorized entities (like words and morphemes, in the case of linguistics, or markets and commodities, in the case of economics), reflects the linguist's or economist's charge to connect human phenomena with mental (and therefore, ultimately physical) law. Nonetheless, even with liberal use of subjective judgments, economics and linguistics (and some other human sciences as well, potentially) are attached to the overall sphere of natural science, by virtue of causal links in principle even if not in practice. Scientific rigor in this humanistic setting is neither reducible to the techniques of natural science, nor dualistically separate from them. Natural science and humanities are certainly not mutually irrelevant, but nor is the proper vehicle for scientific literacy to find a forum in the humanities merely to emulate numeric methods, as with statistics in sociology, or a retreat to narrow and behavioristic reductionism, in place of localized interpretation and situational particularism.

Subjective impressions (conscious experiences, emotions, intuitions, qualia, qualitative universals and particulars — the qualitative characteristic in itself, and the hyletic-spatial trace, the site in experiential space as the quale becomes a moment of consciousness) — these are not scientifically tractable and do not have obvious physical location or measurability, which makes them controversial as objects of scientific method. Yet, even so, we do have conscious experiences, we do subconsciously (and when needed consciously, or with deliberate conscious attention) make judgments about classifications, or how parts aggregate into wholes, or are individuated apart from a larger whole in context; we can reflect on patterns in these judgments, not *introspectively* examining thoughts as they occur, but marshalling an overall

familiarity with mental processes. Consciousness is not only a kind of mentality, shared by humans and some animals; it is also a metacognitive tool, something we deploy to focus attention on a certain object or topic. We "practice" how to *be* conscious, how best to distribute attention, in each setting (like an athlete maintaining a meditative state of ambient awareness, poised to latch conscious attention onto playing technique which is optimally instinctive, but "feels" different when degraded by fatigue or distraction). Our faculty for these modulations, switching among sub- and passive consciousness, attentive consciousness, "ambient" awareness, and back again, reveals that consciousness is not only an aspect of mind but a tool; it has a meta-cognitive and epistemic dimension, an awareness of what is known or not-yet-known and a technique of directing attention to the latter.

A case-study: in a motel I unexpectedly find a newspaper outside the door. Next morning I look outside curious whether a paper is there; after several days I come to expect the paper. So I open the door not preoccupied with confirming this, but with (maybe rather distractedly) fetching it. Initially I do not expect the paper, but, generally poised to notice both expected and unexpected circumstances, I make a mental adjustment and interpret the situation quickly; by the third day the paper has become expected, like other things I anticipate finding in a motel hallway, and the thrust of my attention, during the brief episode of my picking it up, is kinaesthetic and motor-intentional more than visual and inquisitive. Only on the second morning is the question of a paper's presence intended in an epistemic mode; but, while it is so thematized, I direct attention to optimize my ability to resolve the question. How we engage attention is a deliberate choice, reflecting and responding to our metacognitive attitudes, what we think we know and do not know.

Because consciousness is in some ways a mental tool, we have an intimate familiarity with it, a familiarity which extends beyond our own minds: we can make reasonable guesses about what others do or do not know and perceive. Our ability to anticipate others' epistemic states is an intrinsic feature of social interaction, of intersubjectivity; we therefore understand consciousness not only via our own use and possession/experience of it, but as a general feature of the human mind. We can accordingly make structured claims about conscious processes, not in the sense of introspective reports but of retrospective suggestions — by analogy, a pianist on reflection may have alot to say about playing technique, but she does not acquire this wisdom from introspective study of her own playing while it happens; rather with accrued wisdom and reflection. In terms of phenomenological method, our study of thought and consciousness is analogous: it is reflective examination of what it means to be consciously intelligent beings, not introspective psychology, or meditative meta-experience.

The methodological implications of this retrospection (as opposed to *intro*spection), how phenomenological writing seeks reflective consensus on claims about consciousness — this fashion of constructing a research community, a discursive-methodological field, does not conform to empirical scientific method, but is arguably a quite valid and defensible means of meeting the criteriological goals — the discourse ethics, the democratization of scientific participation — which physical science achieves via empiricist Ontology. For all its limitations, Positivism has the one virtue of disputational inclusiveness, demanding potential observability (not some special revelation or insight) for theoretic ur-entities. The civic norms of Phenomenology are more complex, because both "transcendental" analysis of consciousness — as a kind of philosophical ground zero, a neo-Cartesian fortress against skepticism and empiricism — and also a more pluralistic, enculturated, embodied, social Phenomenology, are well-represented (and interpenetrate in complex ways) in the continuing post-Husserl tradition. That being said, even in its most neo-Idealist, reifying consciousness as a primordial frame on any cognitive-scientific reasoning, as human sciences' condition of possibility, Phenomenology cannot help but textually acknowledge pluralism, and philosophical collaboration — precisely because its claims are not descriptive of empirically locatable/observable objects.

Interestingly, the phenomenological tradition reveals substantial interest in both the socio-political and the formal-mathematical: this is not so noteworthy in itself, because Analytic philosophy also connects (say) language with (say) logic, but Phenomenology is distinct in that it joins the humanistic and the formal/mathematical without the same tendency to hone in on a overlapping, logico-semantic core. In writings where Analytic philoso-

phers appear to address both social and mathematical concerns, usually their underlying motivation, or so it seems to me, is to find some logical underpinnings to linguistic or cognitive structure (say, *implicatures*) — logic, subject to formal treatment, also manifesting itself in the organization of thoughts and expressions. Amongst phenomenologists, however, for example Husserl, Merleau-Ponty (in his science-oriented writings; [44]), and Anglo-American writers in the "Naturalizing Phenomenology" tradition, there is evident interest in mathematics *apart from* logic: topology, differential geometry, mereotopology, multi-granularity.[18] Phenomenology therefore uncovers an arguably deeper and truer bridge between human and "eidetic" sciences, in Petitot's phrase, one which is not pre-loaded with logico-reductive presuppositions. If this is accurate, Phenomenology can provide a deeper methodology for the humanities in their interactions with natural science. Even insofar as we stay committed to the idea that social/cultural/mental phenomena emerge from (neuro-)physical ones, we need to curate methods for these "emergent" sciences which have the requisite theoretical autonomy to actually extend the explanatory reach of the natural sciences on which they causally rest. Cognitive Linguistics, I would argue, is a good example of this notion of autonomy, and its methodology, I would also argue, bears an important resemblance to phenomenological research.

Another brief case-study (revisiting footnote **??**): our environing world mostly discloses itself through objects' visible exterior: as much as we have on occasion a palpable sense of volume as well (as when looking through a fog) — and as much as what we see is inextricable from our embodied interactions with objects, adding tactile and kinaesthetic dimensions, a canonical sense of perception is still the vision of distant objects, usually through their surface geometry. A canonical example of perceptual cognition is therefore reconstructing geometry from visual appearances, especially color gradations — mathematically, converting "color" vector fields to curvature vector fields (it's worth noting that color is an almost primordial example of a Conceptual Space Theory as developed by Gärdenfors and others [66]). This kind of transformation, described (say) via differential geometry, is *qua* theoretical device an example of semiotic morphism, a mapping between representation disciplines [27], [26]. The point is not, however, that there are precise correlates in the brain which "implement" this procedure; that the semiotic morphism takes a domain and codomain that quantify over empirically locatable, neurophysical entities. We can study how software reconstructs geometry from color data as an approximation to a *process*, a model-building whose semiotics of approximation is coarse-grained and holisitc.[19] Formal devices like vectors or vector fields need not mold symbolic systems by mapping individual symbols to spacetime objects, or processes, but rather afford representation-mappings that capture cognition indirectly and patternwise.

I make this point using visual consciousness as an example, but it applies also to cognitive grammar, where the color -to- curvature-vector morphism has an analogue in the mapping of word-sequences to tree- or graph-algebras. I do not intend to claim that there are specific, individuated neurophysical analogues to theoretical posits in the symbolic regime I sketched earlier, in terms of POS and lexical annotations, inter-

[18] Not that logic is wholly unrelated to these subjects: consider topological and type/Category-theoretic embeddings of logical systems within certain categories, or technical domains, like toposes, sheaves, granules; but logic in this sense, mathematically founded within spaces otherwise discussed at least as metaphoric guides within Phenomenology, does not appear to be the dominant understanding of logic in the Analytic philosophical tradition. To be fair, style may dictate that argumentation should be trimmed to its essential elements, and mathematical deductions are rarely if ever essential for defending phenomenological claims. In Jean Petitot, for example, mathematics is sometimes intrinsic to empirical backing for phenomenological ideas, but other times (say, sheaf mereology), the formal theories, while useful analogies, do not clearly pair up with logico-deductive justifications. But, I would reply, there is so much unexplained about consciousness, and cognition as it occurs in conscious minds — the controversial "Explanatory Gap" between mind and matter — that much of the important argumentation does not yet have deductive signposts; we need an effective methodology which is not so linear. As we approach beyond a simplifying, logico-functionalist vantage, which we eventually must transcend, both functionalization and empiricism fall by the wayside as reasonable methods for "Naturalizing" consciousness. We have to accept when the formal/mathematical stands as more intuitive than rhetorical, on pain of "Naturalization" being quarantined from a humanistic core entirely.

[19] The experiential verisimilitude of computer graphics is a phenomenological data point, but so is their obvious unreality — the mathematics reveals something about, but is not an all-encompassing model for, shape and color *qua* material phenomenon, still less the neuroscience of color experience. Morphism between structures may model *processes* more correctly than the structures themselves approximate their substrata — but this is no longer a semiotics of causal/physical reductionism, a use of mathematics (like differential geometry) to iconify empirical givens, the way that (say) the Navier-Stokes equations are understood to refer explicitly to (even while idealizing and abstracting from) fluid-mechanical dynamics. Our theory-semiotics has to locate the site of designation at a more oblique scale, a different Ontological register, of processes and transformations — seeing in phenomena the image of a theoretical model because of its global structure, as a sign in its own right, rather than a collage of symbols and numbers to which are reduced spatializations and trajectories of causation and physical influence.

word and inter-phrase connections, applicative structures, and the rest. There are not, necessarily, for example, little brain regions whose role is to represent different types of phrase structures (e.g., different flavors of pluralization). Our explanatory ambitions, instead, should be cognitive-linguistic models of a global process-structure, agnostic about one-to-one correspondence between the posits of the theory and the empirical stuff whose behaviors it wants to explain. Cognitive triggers bridge formal/empirical sciences with the phenomenological/humanistic: their causal engenderings are physical and structural phenomena, but their manifestation in the world is not fully tractable without an interpersonal deliberation accounting for both the privateness of consciousness and the sociality of mind, and, so, something akin to Phenomenology.

It may appear that I am describing a weak-functional theory (or metatheory) which uses functional description in lieu of precise micro-physical explanation — in other words, that in lieu of explaining precisely how the brain achieves vision or language, we describe functional capabilities that are prerequisite for these competences, and refactor the goal of scientific explanation as to describe the system of intermediate functionality as correctly as possible, rather than describe how this functionality is physically realized. In a strong form, this re-orientation yields functionalism in theories/philosophies of Mind, that try to refrain from Ontological commitments to mental states or properties *apart from* descriptions of their functional roles. In other words, according to the parameters of the field of study and its institutions, even if not deep metaphysical beliefs, mental states are reducible to functional states, and cognitive systems are scientifically equivalent if they reveal similar functional organization, whether they belong to human or animal minds or computers or extra-terrestrials. A more modest functionalism would reject the implied reductionistic (maybe eliminative) Ontological stance, and maintain that mental things are not wholly, metaphysically subsumed by their functional organization, while still practicing a kind of theory whereby this functional organization is the proper object of study; the specific aspect of the mental realm which is scientifically tractable.

I do not believe I am making even such weak-functionalist claims: either branch of functionalism can misattribute the methodological association between theoretical structures and explanatory goals. We may be led toward the stronger or weaker functionalist viewpoints if we understand that a cognitive theory should task itself with making symbolic icons for scientifically grounded referents, grounded in an abstract space of functional organization if not in empirical space-time. Of course, most scientific explanation does construct a specialized, technical semiotics whose signs refer into either formal spaces or accounts of empirical space-bound things, however abstracted or idealized. But, conversely, insofar as I propose to focus on functional structures, and particularly cross-representation-framework transformations, my intent is to "functionalize" the discursive norms of the theory, not the phenomena it investigates. In order to negotiate between the competing demands of scientific rigor and formalization — on the one hand — with the immediacy and etheriality and subjectivity of consciousness, on the other, we need to "attach" theoretical structures to mental phenomena without getting bogged down in questions of the scientific or Ontological status of mental things, how they are "scientific" individually and collectively (collectively as in the Ontology of "Mind" overall).

This suggests adopting functional attitudes not in the theory but the metatheory: to use functionalism as an organizing principle on the theoretical *discourse*, on the attitudes of the scientists and scholars who want to straddle the divide between natural and mathematical sciences and humanism and consciousness. The "semiotic morphism" of color-to-curvature vector fields, or word-sequences to typed semantic graphs, are recommendations for guidelines on how researchers should write and communicate about cognitive processes in their global structure. I have tried to outline a metadiscourse more than a metalanguage — not a template for building theory-languages whose signs refer into a realm of posited empirical or abstract entities, but a template for using certain formal-mathematical constructions (in domains like typed lambda calculus, type theory, or differential geometry) as a textual prelude, a way to position the norms of writing to be receptive to both scientific-mathematical and phenomenological concerns. If semiotic morphisms like color-to-curvature or word-sequence-to-semantic-graph have explanatory merit as ways to picture cognitive processes, this merit is intended to be judged according to how it affects discursive norms on this scientific borderlands between mathematics and

humanities, rather than how it reduces empirical phenomena to mathematizable abstractions. If there is *something* in cognition analogous to these morphisms, even if "analogous" means merely that holding the morphisms as formally defined in our minds while thinking about cognition can show us philosophical ways forward, then we should be interested in refining these formalizations as part of the overall Cognitive-Phenomenological project.

The Cognitive-Phenomenological project is very different, I believe, than the AI or Atificial General Intelligence projects. Nevertheless, as I noted to conclude Section 3, AI — for all its reductive ideology — does show the benefits of an intellectual framework where researchers can experiment, try things out, and write code. We should not underestimate the power of technology and experimentation to ground and engage the scholarly process: it allows the scholar to program her own research environment, autonomous as necessary from academic and institutional paradigms — which, notwithstanding a general acaemic commitment to innovation, can get mired in inertia: particularly when it comes to interdisciplinary methodology and particularly when it comes to reengineering the publishing process and the dissemination of scholarship. There is a lot of technical and technological potential which in the acaemic and publishing communities is not being realized.

This is not just a procedural claim tangential to actual scholarly argumentation: we need new generations of publishing tools to properly syntheize computational technology with nonreductive, humanities-based philosophies of mind and consciousness. We need to properly implement the technological tools that empowe individual scholars, without buying uncritically into academic and corporate appropriations of technology for regressive ends.

At the risk of seming to conclude with an infomercial, I'll cite as an example the Conceptual Space Type Theory and Type Expression Language (CSTX), which is currently used in the context of scientific data publication (see my forthcoming chapter in [**?**]). CSTX presents a flexible type theory that can model both natural-langauge phenomena (such as Link Grammar, the internal parsing formalism in OpenCog, and the type-theoretic semantics favored by linguists such as Zhaohuu Luo or James Pustejovsky) as well as formal-language specifications for Software Language Engineering and Requirements Engineering. CSTX allows linguists to consider a type-theoretic representation of linguistic data, or language-as-interface "intermediate structures", *without* presuming that automated (AI/machine-learning) systems could necessarily generate Intermeiate Representations without human intervention. It is not a "practical" software system in the AI sense of enabling useful human-like behavior.

On the other hand, since CSTX *also* provides concrete software-development tools, it does have practical uses outside the AI paradigm. In this sense it perhaps serves as a case-study in concrete software whose practical dimension spurs hands-on experimentation and decentralized, extra-institutional open-source collaboration, but whose theoretical commitments gravitate to cognitive linguistics and phenomenology — while bypassing an AI paradigm that underestimates the cognitive importance but complexity of social-situational awareness and of sensate consciousness. AI is not a canonical arbiter of software practicality (our contemporary instinct toward measuring all software around AI-driven analytics and "Big Data" reflects a clever marketing campaign by companies with financial incentives to prioritize AI research over other disciplines). Nor is AI a value-neutral or politically progressive vision of what human mind and society are like.

Perhaps this is part of what it means to be a phenomenologist in the 21st century: not to reject technology or computational models or to believe in a mode of phenomenological research carried by pure thought, but to embrace — as part of the research infrastructure, of our own respective academic identities — practical software that suggests interesting cognitive-humanistic paradigms without endorsing reductive AI hypotheses. Insofar as scholarship is a social phenomenon, the metaphilosophy of "pure thought" is an illusion anyhow: thory is inevitably mediated by the disciplinary expectations of its audience. Given this reality, software offers a renewed agency and autonomy to the researcher: computer code does not intrinsically know from disciplinary norms, and the code-writer is programming a medium where disciplinary boundaries can fade out — if the program compiles. The programmer does not *argue* for interdisciplinarity; she *implements* it.

Technology, in conclusion, can liberate scholarship from disciplinary inertia in the same gesture as open-source software liberates technology itself from commercial oligarchizing. Good open-source software programs monetary inequalities out of existence; as humanities scholars we have an analogous duty to program disparaties in intellectual capital and influence out of existence. Open-source software is the fiat currency of the digital commons; by analogy, phenomenology is the liberation theology of the intellectual commons. We don't argue for a just and existential foundation of the humanities and the natural/social science interface: we implement it.

Sophisticated but philosophically and morally responsible cognitive-computational paradigms are probably more likely to arise from adding formal methodology and open-sourc experimentalism to a fundamentally humanities foundation, rather than bringing sensitivity to human nuance to a natural-science academic tradition. The reasons for this are institutional as well as intellectual: insofar as formal-computational models are still rather unfamiliar in humanities contexts, practitioners in a hybrid cognitive-computational-humanities orientation can have a level of autonomy that helps us distinguish sophisticated computational models from simplistic philosophical (and commercial) paradigms. And the affordances of open-source code and digital publishing supports a robust but low-cost technological environment, tangential to academic laboratories and hierarchies.

Perhaps this open-source ecosystem is a worthy 21st-century field wherein to continue 20th-century phenomenology. Let's not forget that phenomenology began as a philosophy of mathematics but evolved into a moral, political, and Existential system. Honoring the subtelty of human consciousness is a way to respect the technical priorities of phenomenological philosophy but also the political activism that — certainly often rendered into praxis by the intersectionality of lived experience with race, class, and gender — follows from phenomenological ethics.

Kant's critical philosophy did not only inspire generations of abstract Idealism; it spurred the cosmopolitan ideal of a Community of Nations and the municipalist axiology of, in particular, Kant's 19th century French translator, Jules Barni. Our communal existence is not intrinsically, cognitively, tribal or chauvinistic: the basic adaptation of human minds to ecologies transcends race, class, and culture. Cultural differences are real, but extrnal: enculturation is minds being shaped by the natural and civil infrastructure around us. While preserving nation and comunity as a practical medium, Kantianism unmasks nationalism as a metaphysical gambit. This is perhaps how, for Barni, Critical Philosophy flows organically into municipalist activism: to understand the mind we have to embed ourselves into the cognitive patterning of mind, which means the environs where cognition is honed, which means our urban and neighborhood ecologies. The architecture of cognition lies not only in the cultures we receive via transmission — religion, education, inter-generational ideologies — but in the grid of the streets outside our front door.

The axis from Kant to Barni has 21st century analogs: Husserl as our Kant, and progressive ethical frameworks like Murray Bookshin's libertarian municipalism taking the mantle from Barni's post-1848 variety. But one key difference is that communities are now partly (though of course not entirely) digital, virtual, and technological. So, I believe, part of being a phenomenologist in the 21st century is to — as much as we can, and virtually if need be — implement a municipalism in our time that metastatizes Husserl in a capitulation of how, for example, Barni metastatized Kant. This is not just an abstract exercise, because intellectuals are performing their commitment to humanities scholarship, to the progressive and cosmopolitan spirit of humanitis discourse, in environments far mor challenging than we associated with Western academia — Budapest; Rojava. This is part of what I had in mind referring to "phenomenological ethics".

Wes Enzinna, a New York Times reporter who taught a journalism class at the Mesopotamian Social Sciences Academy in Qamishli, told a story (in the Times Sunday Magazine, November 29 2015) about his reconciliation with students after a brief culture-shock-like falling out:

> "We reject the master-and-slave relationship as a model for the teacher-and-student relationship," Ali said. "But we've decided that you're welcome to continue teaching us." Ramah, the atheist, stood up and said, "I'm so happy you're here." They all approached my desk and turned in their assignments.

Sherhad Naaima, another Kurdish activist a few months earlier, put it this way (in an interview with Eleanor Finley from the Institute for Social Ecology in Vermont):

> History is a river, it cannot be cut. We have no West or East, but rather one history which is moving and retaining all human culture ... [T]he Left needs to dive deeper into hidden history and revive their own traditions of freedom and the idea of a utopia of freedom. They then must build a holistic theory provided by the unity of natural sciences and social sciences. That new theory can be called "the epistemology of freedom".

These testimonies are what "to the things themselves" means today.

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