Semantic Typology and Composition

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Does the meaning of a name like (1) differ in kind from the meaning of a verb phrase like (2)?

(1) Socrates (2) die in Athens

I assume that ‘cat’ and ‘dog’ have meanings of the same sort, even though cats and dogs are animals of different sorts. But what about (1) and (2)? Such questions multiply. Does the meaning of (3) differ in kind from the meaning of (4)?

(3) every (4) every cat

If so, could (1) be an instance of the same “semantic type” as (4)? What about (5) and (6)?

(5) in Athens (6) see Athens

Is (5), a prepositional phrase, an instance of the same semantic type as (2)? Does (6) belong to the same semantic category as its constituent verb? What about the verbs in (6) and (7)?

(7) gave Socrates the cat

Is (8) a phrase of the same semantic type as (9), or perhaps (2)?

(8) Socrates die (9) saw Socrates die

Is (10) an expression of the same semantic type as (8) or (9)? If not, are sentences *sui generis*?

(10) Socrates died.

How many types of expression meaning are there, and are some more basic than others?

One idea is that the spoken (or signed) languages that human children can naturally acquire, given ordinary experience, are languages that generate expressions of many semantic kinds: *denoters* of a basic type <e>, truth-evaluable *sentences* of a basic type <**t**>, and expressions of other nonbasic types characterized by the recursive principle (R);

(R) if <α> and <β> are types, so is <α, β>

where expressions of type <α, β> signify *functions*, from things of the sort signified with expressions of type <α> to things of the sort signified with expressions of type <β>. According to this tripartite proposal, the spoken languages that children regularly acquire—let’s call them Slangs—are importantly like the language that Frege (1879) invented to study the foundations of arithmetic. Many insightful proposals about Slangs have been framed in these terms. But as with the study of Slang syntax, old theoretical vocabulary may need to be replaced as insights emerge.

I think the tripartite proposal is wrong in three ways. In my view, Slangs do not generate expressions of type <e>; they do not generate expressions of type <**t**>; and (R) overgenerates wildly, in a way that is not plausibly constrainable. In the course of defending these claims, I sketch an alternative that is developed in Pietroski (2017): Slangs generate expressions of exactly two semantic types, <M> and <D>, corresponding to monadic representations like ‘Cat(_)’ and dyadic representations like ‘In(_, _)’; and while many lexical items exhibit the relational type <D>, all complex expressions are of the non-relational type <M>, despite the diversity suggested by (1-10). There are some subcategories, but they reflect distinctions that must also be drawn within the Fregean categories <e, **t**> and <e, <e, **t**>>.[1]

1. Some Background and Terminology

Slangs somehow generate expressions that connect meanings with pronunciations in certain ways, but not others. That’s pretty obvious. We can make it a truism by stipulating that meanings are the “interpretations,” whatever they are, that Slangs connect with pronunciations. Though in the present context, any talk of meanings calls for comment.

[1] For reasons that will emerge in section two, I’ll use boldface to highlight appeals to **truth/falsity**.

1.1 Unbounded yet Constrained

Chomsky (1957, 1964, 1965) offers a helpful starting point. Slangs allow for ambiguity, even bracketing lexical homophony of the sort illustrated with 'bank'. English provides unboundedly many examples like 'saw the man with binoculars', which illustrates the phenomenon of structural homophony. This string of words corresponds to more than one phrase, with the result that distinct phrasal meanings share a pronunciation. Yet ambiguity is limited. The phrase 'eager to eat' connects a certain meaning—roughly, that of 'eager to dine/consume'—with a certain pronunciation that is *not* connected with the meaning of 'eager to be eaten/consumed'. In this sense, 'eager to eat' is interestingly *un*ambiguous. The phrase 'easy to eat', whose meaning is roughly that of 'easily eaten/consumed', is unambiguous in the other way; while 'ready to eat' is ambiguous. Speakers of a Slang can know that certain pronunciations have certain meanings, and not others, even if theorists don't know what meanings are.

In general, the expressions of a Slang connect each pronunciation with n but not $n+1$ meanings for some n. In cases of word salad, like 'I have been might there', $n = 0$; cp. 'I might have been there'. In other cases, a string of words can be pronounced in a way that supports two but not three meanings, or three but not four, and so on; see Higginbotham (1985), Berwick et. al. (2011). For example, (11) can be understood in the two ways that are indicated with (11a) and (11b), but not in the third way indicated with (11c).

(11) a dog saw a cat with a spyglass
(11a) A dog saw a cat that had a spyglass.
(11b) A dog saw a cat by using a spyglass.
(11c) #A dog saw a cat and had a spyglass.

This suggests that 'with a spyglass' can be understood as a conjunctive modifier, as indicated in (11a′). Yet (11) *cannot* be understood as shown in (11c′).

(11a′) $\exists x[\mathrm{Dog}(x) \,\&\, \exists y[\mathrm{Saw}(x, y) \,\&\, \mathrm{Cat}(y) \,\&\, \exists z[\mathrm{With}(y, z) \,\&\, \mathrm{Spyglass}(z)]]]$
(11c′) $\exists x[\mathrm{Dog}(x) \,\&\, \exists y[\mathrm{Saw}(x, y) \,\&\, \mathrm{Cat}(y)] \,\&\, \exists z[\mathrm{With}(x, z) \,\&\, \mathrm{Spyglass}(z)]]$

We can add event variables, replacing (11a′) with (11a″), and accommodating (11b) with (11b″);

(11a″) $\exists e \exists x[\mathrm{Dog}(x) \,\&\, \exists y[\mathrm{Saw}(e, x, y) \,\&\, \mathrm{Cat}(y) \,\&\, \exists z[\mathrm{With}(y, z) \,\&\, \mathrm{Spyglass}(z)]]]$
(11b″) $\exists e \exists x[\mathrm{Dog}(x) \,\&\, \exists y[\mathrm{Saw}(e, x, y) \,\&\, \mathrm{Cat}(y) \,\&\, \exists z[\mathrm{With}(e, z) \,\&\, \mathrm{Spyglass}(z)]]]$

where 'Saw(e, x, y)' is satisfied by an ordered triple $<\varepsilon, \alpha, \beta>$ if and only if ε was an event of α seeing β. This is progress. But one wants to know why (11) *cannot* be understood as in (11c″).

(11c″) $\exists e \exists x[\mathrm{Dog}(x) \,\&\, \exists y[\mathrm{Saw}(e, x, y) \,\&\, \mathrm{Cat}(y) \,\&\, \exists z[\mathrm{With}(x, z) \,\&\, \mathrm{Spyglass}(z)]]]$

If 'saw' corresponds to the triadic representation 'Saw(e, x, y)', why can the prepositional phrase modify the 'y'-position or 'e'-position, but not the 'x'-position?[2]

I return to this specific question. But the general point is that Slangs connect meanings with pronunciations in certain constrained ways. These constraints are logically contingent. We can easily imagine languages in which (11) has the interpretation indicated with (11c), or fails to have the interpretation indicated with (11b), or both; and similarly with regard to other examples. So one task, for those who study Slangs, is to explain why structural homophony is constrained in the way it is. A closely related task is to say which meanings Slang expressions can have, and how these meanings are compositionally related.

In providing detailed proposals, we can and should ask whether Slang expressions connect pronunciations with meanings that differ in kind—as opposed to merely differing—and

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[2] Perhaps (11a″) and (11b″) reflect possessive vs. instrumental uses of 'with'. But then the question is why (11c″) is not an available interpretation of (11) given the possessive use.

if so, which kinds are exhibited by the meanings that Slangs connect with pronunciations. These are empirical questions about certain languages that certain primates can naturally acquire. Theorists can't stipulate which meanings a given speaker's Slang connects with a particular pronunciation; and likewise, we don't get to stipulate the typological character of the meanings that Slangs connect with pronunciations. There is no guarantee that these meanings exhibit any interesting typology, much less that the relevant distinctions are to be characterized in terms of denotation, truth, and (R).

(R) if $<\alpha>$ and $<\beta>$ are types, so is $<\alpha, \beta>$

In case this isn't obvious, let me quickly offer three related claims, each elaborated below.

First, constraints on homophony bolster the independently plausible idea that each Slang is an I-language in Chomsky's (1986, 1995) sense: a biologically implementable procedure that *generates* expressions in a certain way. From this perspective, questions about semantic typology are questions about expressions that humans can naturally generate, not invented formulae that might be used as "regimentations" of these expressions. For certain purposes, it can be useful to view natural expressions as analogs of Fregean inventions. But Slang expressions may not be examples of Fregean types, whose instances may not be examples of natural human types.

On Chomsky's view, and mine, humans enjoy I-languages that generate meaning-pronunciation pairs. If an expression of some syntactic type SYN has a meaning of type SEM and a pronunciation of type PHON, then the expression is an example of all three types; and while we can describe an expression as an instance of its syntactic category (e.g., as a Noun Phrase), its syntactic properties are not more essential than its semantic/phonological properties, which are crucial determinants of how the expression can interact with human conceptual/articulatory systems. Questions about the semantic typology exhibited by Slang expressions, and the vocabulary that theorists should use to describe meanings, are on a par with the parallel questions about Slang syntax that Chomsky (1957, 1965, 1986, 1995) focused on.

Second, Frege (1879, 1884, 1892) wanted a language that generated expressions of certain types—e.g., $<<e <e, \mathbf{t}>>, <<e <e, \mathbf{t}>>, \mathbf{t}>>$—that seem to be unattested in the languages that children naturally acquire. In my view, it would be amazing if Frege's focus on the foundations of arithmetic yielded correct descriptions of Slangs, as opposed to a new language whose invented expressions exhibit some scientifically useful types.

Third, Tarski (1944) showed how to provide a truth theory for a first-order predicate calculus whose boundlessly many expressions exhibit *no* semantic typology. The only expressions (a.k.a, well-formed formulae) of such a calculus are *sentences* like (12) and (13).[3]

(12) $Nx \ \& \ Pxy$ (13) $\forall x[Nx \supset \exists y[Pxy \ \& \ Ny]]$

But closed sentences like (13) are not special by virtue of having truth values. Tarskian sentences do not differ in semantic type; they all have satisfaction conditions, recursively specified in terms of sequences of domain entities, with truth characterized as satisfaction by all sequences. There is no upper bound on the number of variables that a sentence can have; compare (12) with (14).

(14) $Nx \ \& \ [Pyz \ \& \ Nw]$

So the sentences are not instances of any Fregean type, or types, and neither are the ampersands.

In providing stipulations according to which (13) is true if and only if every natural number is the predecessor of another, one need not imply that (13) has a truth value, much less that closed sentences denote truth values. Church (1941) showed how to extend a Tarskian

[3] To ease reading, I use 'x', 'y', and 'z' rather than 'x', 'x′', and 'x′′'. Constants can be added as special variables. But however Tarskian variables are spelled, they are elements of an alphabet, not expressions of a special type.

calculus with denoters of types <e> and <**t**>, along with function-denoters like (15) and (16),

(15) $\lambda x.\top$ if Nx, and $\perp$ otherwise

(16) $\lambda w.\lambda z.\lambda y.\lambda x.\top$ if [Nx & [Pyz & Nw], and $\perp$ otherwise

of the types <e, **t**> and <e, <e, <e, <e, **t**>>>>. So while (14) is a constituent of (16), (14) is also an analog of (16) in a Tarskian language that does not generate expressions of Fregean types.

If the expressions of a language exhibit no semantic categories, then every principle governing the interpretation of complex expressions is syncategorematic. Tarski's treatment of sentences like (12-14), provides a model. I don't think Slangs are Tarskian in this sense. But natural linguistic categories have to be *discovered*, and they may not include the Fregean types.

1.2 Procedures Matter

Following Chomsky (1957), we can ask which kinds of recursion are characteristic of Slangs. Some bundles of operations—e.g., those that could generate any language in the Chomsky hieraracy—seem to be more powerful than our natural capacity to build expressions, which is more powerful than some other bundles. With regard to semantic typology, we can likewise try to steer between the Scylla of overgeneration and the Charybdis of undergeneration, keeping Frege and Tarski in mind. If we think of Slangs as (child-acquirable) *procedures* that generate expressions in certain ways—rather than *sets* of expressions that might be generated in various ways—we can compare these natural procedures to invented analogs that generate expressions via clearly specified operations. And if certain procedures generate expressions that exhibit types not attested in Slangs, that is some reason for not identifying Slangs with such procedures.

The procedure/set distinction is clear enough, at least since Church (1941). Consider the set of ordered pairs <x, y> such that x is a whole number, and y is the absolute value of $x - 1$. This set, which has infinitely many elements, can be described in many ways. Given the notion of absolute value, we can talk about the set of pairs <x, y> such that $y = |x - 1|$. We can also employ the notion of a positive square root to talk about $\{<x, y>: y = {}^{+}\surd(x^2 - 2x + 1)\}$. These descriptions correspond to different procedures for computing a value given an argument. A given machine might be able to execute one algorithm but not the other. Church contrasted functions *in intension* with functions *in extension*, and he offered corresponding construals of his lambda expressions: on the intensional construal, $\lambda x.|x - 1|$ and $\lambda x.{}^{+}\surd(x^2 - 2x + 1)$ are distinct but extensionally equivalent procedures; on the extensional construal, $\lambda x.|x - 1|$ is the same set as $\lambda x.{}^{+}\surd(x^2 - 2x + 1)$.[4]

Chomsky (1986) echoed this contrast, describing I-languages as expression-generating procedures. And since the ordinary word 'language' is polysemous, he used 'E-language' to cover languages of any other sort. So if certain "dispositions to verbal behavior" count as languages, along with certain sets of formulae, they are E-languages in Chomsky's sense. But however we count languages, it seems clear that *acquiring* a Slang is a matter of acquiring a biologically implementable *procedure* that generates expressions in certain ways.[5]

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[4] Though as Church (1941, p.3) stressed, if the goal is to talk about *computability*, one wants the intensional construal. Frege (1892) also treated the procedural notion as more basic, distinguishing Functions in his sense from their extensionally individuated "courses of values." And of course, coextensive arithmetic procedures are coextensive at every possible world. Though as Church also stressed, there are various ways of individuating procedures (which he associated with meanings), and hence many notions of functions in intension "involving various degrees of intensionality." See Horty (2007) for related discussion.

[5] Chomsky (1986) also suggested that I-languages are individuated *internalistically* and *individualistically*; cp. Ludlow (2011). But these connotations of 'I-' are not definitional.

From this perspective, ‘English’ is not a name for any single Slang. A speaker *of English* has acquired a generative procedure that can be classified (along with many others) as an English idiolect; cp. a speaker of *a Germanic language*. More importantly, we can view (R)

(R) if <α> and <β> are types, so is <α, β>

as a hypothesis about the kinds of expressions generated by Slangs—human I-languages that allow for structural homophony within certain limits—given some expressions of one or more basic types. I think this hypothesis is interesting but false, and that we should seek a more constrained conception of human semantic typology.

Others are free to reject the hypothesis as an unwise cognitivist gloss of semantic theories, but then suggest some other role that (R) plays in accounts of linguistic meaning. Perhaps there is an interesting sense in which Slang expressions are related (e.g., via canonical uses) to semantic properties that exhibit an (R)-ish typology, even if the expressions do not themselves exhibit this typology. My contrary suspicion is that if (R) does not figure in a good description of the natural generative capacity, it has no important place in theories of Slangs, apart from its role in letting us describe a space of conceivable interpretations for symbols. In any case, I want to focus on—and object to—the following idea: Slangs generate expressions in accord with (R), which is like other principles that linguists formulate in attempts to characterize procedures that children can naturally acquire; see Heim and Kratzer (1998), Jacobson (2014).

Thanks to Frege and the other founders of modern logic, we can imagine a mind that has the following capacities: it can generate expressions of two basic types, <**t**> and <e>, perhaps initially by assigning special labels to sentences and the constants of a Tarskian calculus; it can create expressions of type <e, **t**> by a kind of abstraction on type <e> constituents of type <**t**> expressions; and it can likewise create expressions of the other Fregean types, modulo various performance limitations. I grant that adults, who already have a Slang, can invent and use procedures that generate expressions of types like <<e, **t**>, **t**> and <<e, <e, **t**>>, <<e <e, **t**>>, **t**>>. But my question is whether the Slangs we naturally acquire, as children, are Fregean languages.[6]

2. Unwanted Recursion

Given at least one semantic type, principle (R) implies that there are boundlessly many.

(R) if <α> and <β> are types, so is <α, β>

Initially, this might seem innocuous, since a grammar for a Slang can harmlessly imply that the language has—i.e., generates—boundlessly many expressions. But while any expression of English can be part of another, even if there are limits on the size of expressions that can actually be constructed, it doesn’t follow there are endlessly many *types* of expressions or meanings.

2.1 Rapid Overgeneration

Moreover, given *two* basic types, just a few iterations of (R) yields many, many more.

Consider a basic domain consisting of some entities (e.g., the natural numbers) and two truth values, ⊤ and ⊥. We can view <e> and <**t**> as types that constitute Level Zero of a hierarchy whose next level includes four types: <e, e>; <e, **t**>; <**t**, e>; and <**t**, **t**>; where each of these types corresponds to a class of functions from things of some Level Zero sort to things of

[6] We can talk about sets that connect pronunciations with “ideal” interpretations that rational creatures could agree on without acquiring human I-languages; see, e.g., Lewis (1975). Imagine the pronunciation of ‘Bert’ being used to signify Bertrand Russell, perhaps via various definite descriptions and Tarskian constants. If such uses have a shared singular content, the public expression ‘Bert’ may be of the ideal type <e>. But my question concerns meanings, not ideal communicative contents. If the distinction is denied, we can say that Slangs connect meenings with pronunciations, and that as meeningful expressions are used, they may acquire meanings/contents. Then the question is whether meenings exhibit a Fregean typology

some Level Zero sort. Put another way, Level Zero is exhausted by the two basic Fregean types, which can be described as <0> types. Level One is exhausted by the four <0, 0> types. At the next level, there are the new types that can be formed from those at the two lower levels:

eight <0, 1> types, including <e, <e, **t**>> and <**t**, <**t**, e>>;
eight <1, 0> types, including <<e, e>, e>> and <<**t**, **t**>, **t**>; and
sixteen <1, 1> types, including <<e, e>, <e, e>> and <<e, **t**>, <**t**, **t**>>.

So at Level Two, there are thirty-two types, each corresponding to a certain class of functions. At Level Three, there are 1408 new types that can be formed given those at the three lower levels:

sixty-four <0, 2> types, including <e, <e, <e, **t**>>>;
sixty-four <2, 0> types, including <<e, <e, **t**>>, **t**>;
one-hundred-and-twenty-eight <1, 2> types, including <<e, **t**>, <<e, t>, **t**>>;
one-hundred-and-twenty-eight <2, 1> types, including <<e, <e, **t**>>, <e, **t**>>; and
one-thousand-and-twenty-four <2, 2> types, including <<e, <e, **t**>>, <e, <e, **t**>>>.

At Level Four, there are more than two million types: <e, <e, <e, <e, **t**>>> and 5631 more <0, 3> or <3, 0> types; 11,264 <1, 3> or <3, 1> types; 90,112 <2, 3> or <3, 2> types; and 1,982,464 <3, 3> types. (Compare the "iterative conception" of the Zermelo-Frankl sets, as discussed by Boolos 1998.) Let's not worry about Level Five, at which there are more than 5 x 10^{12} types. But it is worth thinking about Levels Three and Four. I'll return to the lower levels in section three.

Let 'e**t**' abbreviate '<e, **t**>', and consider the Level Three type <<e, e**t**>, **t**>. Functions of this type map functions like λy.λx.**Predecessor**(x, y)—i.e., λy.λx.⊤ if Predecessor(x, y), and otherwise ⊥—onto to truth values.[7] So following Frege, one can use invented expressions of type <<e, e**t**>, **t**> to encode various judgments concerning properties of first-order dyadic relations. For example, λy.λx.**Predecessor**(x, y) is not transitive, but λy.λx.**Precedes**(x, y) is; and these judgments can be reported with (17) and (18).

(17) ~**TRANSITIVE**[λy.λx.**Predecessor**(x, y)]
(18) **TRANSITIVE**[λy.λx.**Precedes**(x, y)]

Fregean languages also support abstraction over the dyadic relations. For example, the function λ**D**.**TRANSITIVE**(**D**) maps λy.λx.**Precedes**(x, y) to ⊤, while mapping λy.λx.**Predecessor**(x, y) to ⊥. One can also encode thoughts concerning relations among relations—and in particular, the thought that precedence is the transitive closure or "ancestral" of the predecessor relation—in a logically perspicuous way. Indeed, as Frege (1879, 1884) showed, the real power of his logic is revealed with expressions of the Level Four type <<e, e**t**>, <<e, e**t**>, **t**>> as in (19).

(19) **ANCESTRAL-OF**[λy.λx.**Precedes**(x, y), λy.λx.**Predecessor**(x, y)]

Note that λ**D′**.λ**D**.**ANCESTRAL-OF**(**D**, **D′**) is like λ**D**.**TRANSITIVE**(**D**) in being second-order, and like λy.λx.**Predecessor**(x, y) in being dyadic; compare λ**D**.ANCESTRAL(**D**), which maps λy.λx.**Predecessor**(x, y) to λy.λx.**Precedes**(x, y). In providing this kind of symbolism, Frege thought he was offering a *new* way of representing relations among relations. He thought he needed to invent languages that generated sentences, of a basic type <**t**>, whose constituents could include expressions of the abstract type <<e, e**t**>, <<e, e**t**>, **t**>>. One can use a Slang to say, long-windedly, that the relation of precedence is the transitive closure of the smallest relation that one number bears to another if and only if the first is the predecessor of the

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[7] Crucially, **Predecessor**(2, 3) is a truth value, Predecessor(3) is a number, and **Prime**(2) is a truth value. So even "monadic" functions of type <e, **t**> are relational, since they map entities to truth values. In this sense, the functions λx.Predecessor(x) and λx.**Prime**(x) are on a par. For simplicity, I ignore Frege's talk of Functions/Concepts being *unsaturated*, and use lambda expressions to talk about denotable functions as in Church (1941).

other. In this sense, we can gesture at the content of (19) with naturally generable locutions. But this requires circumlocution, in which we talk about relations as things; and prima facie, the nominalizations fail to reflect certain logical relations among the relations and relata. By contrast, we can imagine minds that naturally generate (17-19) and pronounce them as we would pronounce (17a-19a), using verb-like words of types $\langle\langle e, e\mathbf{t}\rangle, \mathbf{t}\rangle$ and $\langle\langle e, e\mathbf{t}\rangle, \langle\langle e, e\mathbf{t}\rangle, \mathbf{t}\rangle\rangle$.[8]

(17a) Predecessor doesn't transit.

(18a) Precede transits.

(19a) Precede ancests predecessor.

Frege showed how a possible mind—one that enjoys a competence partly characterized with (R)—could generate expressions of much higher types.

(R) if $\langle\alpha\rangle$ and $\langle\beta\rangle$ are types, so is $\langle\alpha, \beta\rangle$

Though one can also imagine such a thinker being subject to performance limitations. Perhaps she cannot naturally employ expressions of types above Level Four, given the memory needed to abstract and store such expressions. Such a thinker might, qua theorist, know that she has an I-language that generates expressions of type $\langle\langle e, \langle e, e\mathbf{t}\rangle\rangle, \langle\langle e, \langle e, e\mathbf{t}\rangle\rangle, \mathbf{t}\rangle$. But this might be akin to our theoretical appreciation of the fact that (20) is a sentence.

(20) The rats the cats the dogs chased chased fight bulldogs bullodogs fight.

So the mere unavailability of Level Five expressions doesn't show that a thinker doesn't have a competence characterized with (R); and many expressions of lower types like $\langle\mathbf{t}, \langle e, \langle\mathbf{t}, e\rangle\rangle\rangle$ might correspond to functions (i.e., intensions) that thinkers find unnatural, even if such expressions are available in principle. But my concern is not merely that endlessly many Fregean types, including the vast majority of "lower" types, are unattested in human languages. My initial concern is that humans can, and with a little help *do*, grasp the thoughts indicated with formalism like (17-19). So why can't we pronounce these thoughts by simply introducing words like 'ancests', and using expressions like (17a-19a), if Slangs permit expressions of Fregean types?

One can always posit constraints on how competences get used. So one can still hypothesize that our semantic competence is fundamentally Fregean. Perhaps Slangs allow for (17a-19a), but other aspects of human nature keep us from naturally constructing and using such expressions, even though we can invent and use (17-19). There may be barriers to introducing lexical items of certain Fregean types. But the coherence of this position is not an argument that it is correct. We have independent reasons for thinking that Slangs generate expressions like (20), and some not implausible accounts of why this kind of embedding makes expressions hard to parse. So one wants to see reasons for thinking that Slangs generate expressions of Level Three and Level Four types, along with accounts of why expressions of types $\langle\langle e, e\mathbf{t}\rangle, \mathbf{t}\rangle$ and $\langle\langle e, e\mathbf{t}\rangle, \langle\langle e, e\mathbf{t}\rangle, \mathbf{t}\rangle\rangle$ are unattested, even though we can comprehend (17-19).

Here is another way of indicating the concern; cp Chierchia (1984). Abstraction on the subject or object position of (21), as in (21a) and (21b), is easy. So why isn't (21c) available,

(21) The plate outweighs the knife.

(21a) The plate is something *which outweighs the knife*.

(21b) The knife is something *which the plate outweighs*.

(21c) *Outweighs is something *which the plate the knife*.

with the italicized phrase understood as a relative clause of type $\langle\langle e, e\mathbf{t}\rangle, \mathbf{t}\rangle$? (If 'something' or 'which' imposes a type restriction, why can't we have 'somerel whonk the plate the knife'?) And why can't we use (22c) to say that $\lambda y.\lambda x.$**Precedes**(x, y) is a relation that three bears to four?

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[8] Such words would differ from verbs that can combine with *names* of relations, and perhaps correspond to events/states of being transitive (or being the transitive closure of a certain relation).

(22) Three precedes four.
(22a) Three is something *that precedes four*.
(22b) Four is something *that three precedes*.
(22c) *Precedes is something *that three four*.

2.2 Unrelational Quantifiers

It is often said that words like ‘every’ and ‘most’, as in (23) and (24),

(23) Every cat ran quickly.
(24) Most cats ran quickly.

are instances of the Level Three type <e**t**, <e**t**, **t**>>. The idea is that modulo niceties regarding tense and agreement, a determiner combines with an “internal” argument of type <e**t**> and an “external” argument of the same type, much as ‘precedes’ can combine with two arguments of type <e>. On this view, ‘every’ and ‘most’ indicate relations that are exhibited by functions of type <e**t**>. Correlatively, the types <e, <e**t**>> and <e**t**, <e**t**, **t**>> instantiate the abstract pattern <α, <α, **t**>>. But <<e, e**t**>, <<e, e**t**>, **t**>> also exhibits this pattern. So if some human words indicate functions of type <e, e**t**>, and our I-languages are characterized by (R),

(R) if <α> and <β> are types, so is <α, β>

we should be able to generate expressions of type <<e, e**t**>, <<e, e**t**>, **t**>>. Even if *verbs* cannot have meanings of this type, one wants to know why humans can’t naturally use Slangs to form expressions like (25); where ‘Ancestral predecessor’ is a constituent of type <<e, e**t**>, **t**>.

(25) Ancestral predecessor precede.

What precludes (25) if ‘Every cat’ is a constituent of type <e**t**, **t**> in (23)?

This bolsters other reasons for suspecting that determiners do not have meanings of type <e**t**, <e**t**, **t**>>. One obvious question is why (26) *fails* to have a sentential reading.

(26) every cat which ran quickly

If ‘which ran’ exhibits any Fregean type, it is presumably <e**t**>. But if the relative clause is an instance of this type, why can’t (26) be understood as a sentence roughly synonymous with (23)?

(23) Every cat ran quickly.

One can say that for some syntactic reason, ‘every’ cannot take a relative clause as its external argument, and must instead take a smaller clause of the same semantic type. But the issue is deeper. We can specify the meaning of (23) as follows: for every cat, there was an event of it running quickly. And I am happy to say that ‘Every cat’ raises—leaving a trace of displacement—so that the determiner’s external argument is a *sentential* expression akin to (27).

(27) It ran quickly.

But if the determiner’s external argument is sentential, like (27), then one needs an ancillary assumption to maintain that ‘every’ is of type <e**t**, <e**t**, **t**>>.

Heim and Kratzer (1998) are admirably explicit about this. On their view, (23) has the form shown in (23a), with the indexed trace interpreted like the pronoun in (27).

(23a) $[[\text{every cat}]_{<et,\,t>} [1\ [t_1 \text{ ran quickly}]_{<t>}]_{<et>}]_{<t>}$

The index is a syncategorematic element that gets reproduced in the structurally higher position, thereby converting a sentential expression of type <**t**> into an expression of type <e**t**>.[9] The index is not posited as an expression of type <**t**, e**t**>; but neither is the displaced element in $[\text{which}_1\ [t_1 \text{ ran quickly}]_{<t>}]_{<et>}$. Like Heim and Kratzer, I think we need to posit a

[9] Heim and Kratzer posit a rule according which: if a sentence S contains a trace with index *i* and combines with a copy of *i*, the result is an expression of type <e**t**>; and relative to any assignment 𝒜, *i*^S indicates a function that maps each entity e to ⊤ iff S denotes ⊤ relative to the minimally different assignment 𝒜* that assigns e to *i*.

syncategorematic operation of abstraction, corresponding to Tarski-style quantification over ways of assigning values to indices. So my concern is not that (23a) includes an element that is not an instance of any Fregean type. My concern is that (23a) posits an element that effectively converts the external/sentential argument of ‘every’ into a relative clause—thereby effacing the apparent contrast with internal/nominal arguments—even though quantificational determiners cannot take relative clauses as external arguments. Given that (26) cannot be understood as a sentence that is roughly synonymous with (23), it seems odd to say that in (23), ‘Every cat’ combines with an expression whose meaning is that of ‘which ran quickly’.

Absent the stipulation that $[t_1$ ran quickly$]_{\langle t\rangle}$ combines with a syncategorematic element to yield an expression of type <e**t**>, why think that ‘every cat’ is of type <e**t**, **t**>—i.e., an expression that can combine with an expression of the same type as a relative clause—given that (26) cannot be understood as a sentence in which ‘every cat’ combines with a relative clause? Perhaps ‘every’ abhors relative clauses, even though it indicates a dyadic relation exhibited by functions of type <e**t**>, and its external argument gets converted into something that looks like a relative clause. But even if this position is coherent, that does not make it plausible.

Moreover, if words like ‘every’ indicate second-order dyadic *relations*, one wants to know why these relations are invariably *conservative* in Barwise and Cooper’s (1981) sense; see also Higginbotham and May (1981). My suggestion is that the antecedent of this conditional is false. In my view, words like ‘every’ are not instances of the Fregean type <e**t**, <e**t**, **t**>>; so they are not special cases of this type.

In a domain of sets, a first-order relation **R** of type <e, e**t**> is conservative if and only if $\forall s'\forall s[\mathbf{R}(s', s) \equiv \mathbf{R}(s \cap s', s)]$. For example, *inclusion* is conservative: s′ includes s—i.e., s′ is a (perhaps improper) superset of s—if and only if the intersection of s and s′ includes s. Note that {1, 2, 3} includes {1, 2}, and their intersection includes/is {1, 2}; but {1, 2, 3} doesn’t include {3, 4, 5}, and neither does their intersection. Likewise, s′ overlaps s—i.e., s′ intersects with s—if and only if the intersection of s and s′ overlaps s: {1, 2, 3} overlaps {3, 4, 5}, and so does their intersection; but {1, 2, 3} doesn’t overlap {4, 5, 6}, and neither does their intersection. So we can say that λY.λX.**Overlap***(X, Y) is a conservative function of type <e**t**, <e**t**, **t**>>; where functions of type <e**t**> overlap* if and only if their extensions overlap. Likewise, λY.λX.**Superset***(X, Y) is conservative. But λY.λX.**Subset***(X, Y) is not conservative; while {1, 2, 3} *isn’t* a subset of {3, 4, 5}, their intersection *is* a subset of {3, 4, 5}.

I take it as given that the first word in (28), which can be added to (29) at many points,

(28) Only cats ran.

(29) The cats think they are clever.

is not a determiner whose meaning is λY.λX.**Subset***(X, Y); see, e.g., Herburger (2001). But this raises the question of why kids *don’t* acquire a determiner ‘Ryev’ that is the semantic converse of ‘Every’. More generally, for each asymmetric conservative relation, there is a corresponding nonconservative relation.[10] The symmetric relations **Identical**(s′ s) and **Equinumerous**(s′ s) are also nonconservative: {1, 2, 3} isn’t identical, or even equinumerous, with {1, 2}; but the intersection of these sets is identical, and hence equinumerous, with {1, 2}. So if ‘every’ is of the same semantic type as ‘λY.λX.**Superset***(X, Y)’, we need some explanation for the absence of determiners—call them ‘ident’ and ‘equi’—that indicate the functions λY.λX.**Identical***(X, Y) and λY.λX.**Equinumerous***(X, Y).

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[10] Given λY.λX.**Overlap***(X, Y) & **Singleton***(Y) for ‘the’, consider λY.λX.**Overlap***(X, Y) & **Singleton***(X).

Putting the point another way, a sentence like (30) can be glossed as in (30a),

(30) Every/Some/No cat ran.

(30a) Every/Some/No cat is one which ran.

with ‘one’ serving as kind of anaphoric restriction. Likewise, all/none/most of the cats ran if and only if all/none/most of the cats are cats which ran. But if there were sentences like (31),

(31) Ryev/Ident/Equi cat ran.

they wouldn’t be paraphrasable with (31a) if the first words were of type <e**t**, <e**t**, **t**>>.

(31a) Ryev/Ident/Equi cat is a cat which ran.

This asymmetry, between *internal/nominal/restrictor* and *external/sentential/scope* arguments of determiners, can be described in many ways. But why should there be any such asymmetry if determiners are of type <e**t**, <e**t**, **t**>>?[11] Eliminating the grammatical distinction between the internal and external arguments, in order to treat both as instances of the Fregean type <e**t**>, seems a like bad idea. One can posit a filter on otherwise admissible meanings. But prima facie, this is a manufactured solution to a deeper problem, endemic to the idea that Slang determiners instantiate a second-order relational type. If a determiner displaces from its original position in some sentential expression S, one would expect the determiner to recombine with S itself, as opposed to a more complex expression that is more like a relative clause.

2.3 Sidebar: Abstracting on Abstractions is Math (not Grammar)

The point of the last few paragraphs is not merely that words like ‘every’ are not examples of the Level Three type <e**t**, <e**t**, **t**>>. Similarly, the point about transitivity and ancestrals was not merely that Slangs seem unlike Frege’s *Begriffsschrift*, in that the natural human languages seem to abhor expressions of the Level Four type <<e, e**t**>, <<e, e**t**>, **t**>>. I think that whatever the basic types are, Slangs don’t generate expressions that exhibit types of the form $\langle\alpha, \langle\alpha, \beta\rangle\rangle$.

Initially, (32) might be described in classical Subject-Predicate terms, as in (32a);

(32) Felix is a cat.

(32a) $[\text{Felix}_{\langle Subj\rangle}\ [\text{is cat}_{\langle Pred\rangle}]_{\langle Pred\rangle}]_{\langle Sent\rangle}$

where ‘a’ is treated as a syncategorematic indicator of a singular count noun, and variants of the copular verb ‘be’ are treated as syncategoremata that are used to create tensed predicates. One might then say that ‘every’ is another syncategorematic expression that combines with suitable predicates to form subjects, as in (23b),

(23b) $[[\text{every cat}_{\langle Pred\rangle}]_{\langle Subj\rangle}\ \text{ran}_{\langle Pred\rangle}]_{\langle Sent\rangle}$

while a transitive verb like ‘chased’ is a syncategorematic device that can combine with suitable subjects to form predicates, as in $[\text{chased Felix}_{\langle Subject\rangle}]_{\langle Predicate\rangle}$]. But instead of positing so much syncategorematicity, one might say that ‘every’ is an instance of <Pred, Subj> as in (23c).

(23c) $[[\text{every}_{\langle Pred,\ Subj\rangle}\ \text{cat}_{\langle Pred\rangle}]_{\langle Subj\rangle}\ \text{ran}_{\langle Pred\rangle}]_{\langle Sent\rangle}$

Similarly, one could say that copulas and transitive verbs instantiate the nonbasic types <Pred, Pred> and <Subj, Pred>. Then (33) might be described as in (33a).

(33) Fido chased every cat

(33a) $[\text{Fido}_{\langle Subj\rangle}\ [\text{chased}_{\langle Subj,\ Pred\rangle}\ [\text{every}_{\langle Pred,\ Subj\rangle}\ \text{cat}_{\langle Pred\rangle}]_{\langle Subj\rangle}]_{\langle Pred\rangle}]_{\langle \mathbf{Sent}\rangle}$

Though given boundlessly many examples like (34) and (35),

(34) Every cat chased every cat.

(35) Felix chased a dog that every cat chased.

it seems that a transitive verb combines asymmetrically with two arguments. This invites further abstraction, perhaps with ‘chased’ described as an instance of <Subj, <Subj, Sent>> and <Subj>

[11] One can say that ‘Every cat ran.’ has the structure $[[\text{every cat}]_{\langle et,\, t\rangle}\ [\cancel{\text{one [which}}_1\ [t_1\ \text{ran}]_{\langle t\rangle}]_{\langle et\rangle}]_{\langle et\rangle}]_{\langle t\rangle}$. But then it is even harder to explain why ‘every cat which ran’ cannot mean that every cat ran.

redescribed as <Pred, Sent>.[12] This way of describing Slangs characterizes predicates and sentences as expressions of basic semantic types; and the classical category of Subject is redescribed as non-basic. In my view, this hypothesis about Slang typology is wrong, and so is the more familiar neo-Fregean hypothesis.

Given the type <Sent>, along with either <Pred> or <Subj>, the recursive principle (R) characterizes a space of types that correspond to possible abstractions.

(R) if <α> and <β> are types, so is <α, β>

Replacing <Sent> and <Subj> with <**t**> and <e> yields a hypothesis about the space of meaning types that Slang expressions can exhibit. But in evaluating any such hypothesis, we need to think about what Slangs *don't* generate, and not just possible ways of describing what Slangs do generate. If 'every' can combine with two predicates to form a sentence, then for some purposes, it does no harm to describe the meaning of 'every' (*a la* Frege) in terms of abstractions from sentence meanings. But positing meanings of type <Pred, <Pred, Sent>> or <e**t**, <e**t**>, **t**>> raises the question of why the meanings that are allegedly of this type respect the constraints they do. Similarly, if 'predecessor' and 'precedes' are described as instances of some relational type <τ>, then one wants to know why the type <τ, <τ, **t**>> is *un*attested if <**t**> is a basic type. In short, describing Slangs in terms of (R) turns many absences into puzzles.

2.4 Ubiquitous Overgeneration

The more than two million types at Level Four include <<e, e**t**>, <<e, e**t**>, **t**>>. This type was especially important to Frege, who wanted to talk about how the predecessor relation is related to the more inclusive relation of precedence. But perhaps some natural limitation blocks dyadic abstractions across dyadic relations—like **λD′.λD.ANCESTRAL-OF(D, D′)**—while still allowing for semantic types like <e**t**, <e**t**, **t**>> and <e, e**t**>. Yet even if this ancillary hypothesis is correct, the Level Four types also include <e**t**, <e**t**, <e**t**, t>>>> and <e, <e, <e, <e**t**>>>>. So if these types are unattested in Slangs, one wants to know why.

It isn't hard to imagine "ditransitive" quantificational determiners like 'Glonk' in (36).

(36) Glonk dogs cats are brown.

Such words would combine with three predicates, yielding a meaning like that of (36a) or (36b).

(36a) The brown dogs outnumbered the brown cats.

(36b) There some brown dogs or some brown cats.

Nor is it hard to imagine a "tritransitive" verb that appears in sentences like (37),

(37) A dog sald a cat a car a dollar.

with the meaning indicated in (37a/b).

(37a) A dog sold a cat a car for a dollar.

(37b) A dog sold a car to a cat for a dollar.

For these purposes, let's not worry about the indefinite descriptions. Suppose that 'sald' would be of type <e, <e, <e, <e**t**>>>> and not the Level Five type <e**t**, <e**t**, <e**t**, <e**t, t**>>>>. For now, let's also ignore adverbial modification as in (38) and the need for an event variable.

(38) Yesterday, a dog happily sald a cat a dollar in Boston.

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12 Then instances of <Pred, Subj>—including 'every'—could be redescribed as instances of <Pred, <Pred, Sent>>. These steps in the direction of a categorial grammar raise many interesting questions about how to spell out the details; see, e.g., Jacobson (1999), Steedman (1996). But appeals to derived types raise the question of which types are basic. Frege argued that logicians don't need the notion of "Subject," which covers denoters and quantifiers; and Chomsky (1957, 1965) argued that linguists should replace the traditional notion with "NP of S," corresponding to a rule like "S ➔ NP aux VP." Though one wants to know why the Subject-Predicate distinction is intuitive if <Sent> is not a *basic* category that corresponds to the "Start" symbol in a phrase structure grammar.

The important point is that we seem to have a concept of selling that differs in adicity from the corresponding concept of giving. A seller gets something back, as part of the exchange. So why don't we have a verb whose type matches that of the tetradric Fregean concept SOLD(X, Y, Z, W)? String (39) is anomalous, not a simpler way of saying that Fido sold a car to Felix for a dollar.

(39) *Fido sold Felix a car a dollar.

But why use the prepositional phrase '*for* a dollar' if verbs can be of type <e, <e, <e, <e**t**>>>>? And note that (40) has the meaning indicated in (40a), with no implication that Fido sold a car.

(40) Felix bought Fido a car for a dollar.

(40a) Felix bought a car for (the benefit of) Fido (in exchange) for a dollar.

One can speculate that some limitation on the use of Slangs precludes expressions of any semantic types from above Level Three. But given (R),

(R) if <α> and <β> are types, so is <α, β>

one needs to posit further constraints, and not just a "conservativity filter" on meanings of type <e**t**, <e**t**, **t**>>. Recall that **λD.TRANSITIVE(D)** is of the Level Three type <<e, e**t**>, **t**>. One can say that while <e, e**t**> and <**t**> are attested types, some performance limitation blocks further abstraction. But at this point, the question is why appeal to (R) and the requisite ancillary assumptions is better than appeal to a *list* of attested types. Moreover, a cluster of facts suggest that <e, <e, <e**t**>>>—arguably the simplest Level Three type—is not attested, not even by lexical items that would seem to be prime candidates.

I assume that humans, along with many other animals, can have the triadic concept BETWEEN(X, Y, Z). So one might have expected 'between' to indicate such a concept, and appear in sentences like (41), if human words can be of type <e, <e, e**t**>>;

(41) Fido between Garfield Harriet.

where 'between Garfield' would be a constituent of type <e, e**t**>. But instead, we have the circumlocutory (42), as if Slangs abhor lexical analogs of triadic concepts.

(42) Fido is between Garfield and Harriet.

Similarly, we seem to have a triadic concept of jimmying that relates a jimmier to both a thing jimmied and an instrument. Yet we resort to prepositional phrases, as in (43),

(43) A thief jimmied a lock with a screwdriver.

instead of introducing a verb of higher adicity as in (44); see Williams (2005, 2007, 2015).

(44) *A thief jimmied a lock a screwdriver.

Examples like (45) initially suggest that some human words are of type <e, <e, e**t**>>.

(45) A dog gave a cat a car.

But the verbs in ditransitive *constructions* may not be semantically triadic; cp. (46).

(46) A woman kicked a dog a bone.

With regard to meaning, and perhaps with regard to syntax, the "indirect objects" are plausibly more like the prepositional phrases in (45a) and (46a); see Larson (1988) and Baker (1998).

(45a) A dog gave a car to a cat.

(46a) A woman kicked a bone to a dog.

Though for present purposes, it doesn't matter which of the arguments in sentence (45) is not an argument of the *verb* 'give'. Perhaps some verbs really do have Level Three meanings. But the absence of evidence for such verbs is striking.

3. Events and Predicates

One might reply that while 'give' and 'kick' are of the same semantic type, along with 'sell' and 'chase', this type is at Level Three. Given independent motivation for event variables, perhaps many verbs are of type <e, <e, *e***t**>>; where the italicization is simply a reminder that 'e' ranges over a domain that includes *events* in which entities may participate. As a defense of (R),

(R) if $\langle\alpha\rangle$ and $\langle\beta\rangle$ are types, so is $\langle\alpha, \beta\rangle$

this seems odd. For the idea is not that '*e*' corresponds to yet another abstracted position, with 'sell' and 'give' exemplifying Level Five and Level Four types. Rather, limitations to Level Three are assumed, with paradigmatically transitive verbs as alleged instances of a Level Three type. Moreover, the questions about $\lambda\mathbf{D}.\mathbf{TRANSITIVE}(\mathbf{D})$ and $\lambda z.\lambda y.\lambda x.\mathbf{Between}(x, y, z)$ remain. But in any case, appealing to event variables casts further doubt on the idea that verb meanings are fundamentally relational.

3.1 Severing Agents

Drawing on Davidson (1967), theorists might initially describe the meaning of (47) with (47a).

(47) A dog chased a cat.

(47a) $\exists e{:}\mathbf{Past}(e)[\exists x{:}\mathbf{Dog}(x)[\exists y{:}\mathbf{Cat}(y)[\mathbf{ChaseByOf}(e, x, y)]]$

But 'chase' may not be an instance of type $\langle e, \langle e, e\mathbf{t}\rangle\rangle$. There are other options. Consider (47b),

(47b) $\exists e{:}\mathbf{Past}(e)[\exists x{:}\mathbf{Dog}(x)[\mathbf{DoneBy}(e, x)]\ \mathbf{\&}\ \exists y{:}\mathbf{Cat}(y)[\mathbf{ChaseOf}(e, y)]]$

in which the ampersand conjoins expressions of type $\langle e\mathbf{t}\rangle$. And '$\mathbf{ChaseOf}(e, y)$' might be replaced with '$\mathbf{Chase}(e)\ \mathbf{\&}\ \mathbf{DoneTo}(e, y)$'. Kratzer (1998) severs Agent-representations from verb meanings. Schein (1993, 2002) urges more general thematic separation; see also Pietroski (2005), Williams (2007). Here, let me note one cluster of considerations that motivate at least Kratzer-style severing, and so *not* specifying verb meanings as instances of type $\langle e, \langle e, e\mathbf{t}\rangle\rangle$.

The passive (48) presents difficulties if 'chase' is semantically triadic.

(48) A cat was chased.

There is no independent grammatical evidence that (48) has a covert subject, analogous to the overt subject in (49).

(49) Something chased a cat.

To be sure, (48) seems to imply (49). But this may be due to our knowledge that chases have chasers, not that 'chase' requires a subject; cp. (50), which in my view, doesn't imply (51).

(50) An icecube melted.

(51) Something melted an icecube.

One might try to accommodate (48) with a "passivizing" morpheme of the Level Four type $\langle\langle e, \langle e, e\mathbf{t}\rangle\rangle, \langle e, e\mathbf{t}\rangle\rangle$. But we can say instead that 'chase' is of type $\langle e, e\mathbf{t}\rangle$. Then combining 'chase' with one argument yields a phrase of type $\langle e\mathbf{t}\rangle$; and (49) can be accommodated with a Kratzerian "voice head" of the Level Three type $\langle e\mathbf{t}, \langle e, e\mathbf{t}\rangle\rangle$. On this view, (49) has two verbal heads, each supporting one argument; see also Borer (2005), Lohndal (2014).

This suggests an explanation for why (11), *doesn't* have the reading indicated with (11c).

(11) a dog saw a cat with a spyglass

(11a) A dog saw a cat that had a spyglass.

(11b) A dog saw a cat by using a spyglass.

(11c) #A dog saw a cat and had a spyglass.

If 'saw' is eventish but semantically *dyadic*, with no variable for who did the seeing, then (52)

(52) see a cat with a spyglass

can be understood as (52a) or (52b), but not as (52c).

(52a) $\exists y{:}\mathbf{Cat}(y)[\mathbf{SeeingOf}(e, y)]\ \mathbf{\&}\ \exists z{:}\mathbf{Spyglass}(z)[\mathbf{With}(y, z)]$

(52b) $\exists y{:}\mathbf{Cat}(y)[\mathbf{SeeingOf}(e, y)]\ \mathbf{\&}\ \exists z{:}\mathbf{Spyglass}(z)[\mathbf{With}(e, z)]$

(52c) $\#\exists y{:}\mathbf{Cat}(y)[\mathbf{SeeingByOf}(e, x, y)]\ \mathbf{\&}\ \exists z{:}\mathbf{Spyglass}(z)[\mathbf{With}(x, z)]$

By contrast, we face two related difficulties if 'see a cat' is an expression of type $\langle e, e\mathbf{t}\rangle$ that can be modified by 'with a spyglass' or another phrase of type $\langle e\mathbf{t}\rangle$. First, accommodating the actual readings of (52) requires either a covert element of type <*e***t**, <<e, *e***t**>, <e, *e***t**>>> or an equivalent rule of "restriction" for dyadic predicates, as in Chung and Ladusaw (2003). Second, blocking the unwanted reading requires a notion of restriction according to which the monadic predicate *can and must* skip over the first available position in the dyadic predicate. One can stipulate that this is how adverbial modification works. But then the question is why *only* adverbial modification is possible. In a Fregean language, (11) could have all three readings.

Appeal to Kratzer-style severing presupposes that a verb phrase can be *conjoined* with a predicate like '**∃**x:**Dog**(x)[**DoneBy**(e, x)]'. But positing a rule of Predicate Conjunction, as in Heim and Kratzer (1998)—or a covert element of the Level Three type <*e***t**, <*e***t**, *e***t**>>—is arguably no worse than appealing to quantificational meanings of type <e**t**, <e**t**, **t**>> and a voice head of type <*e***t**, <e, *e***t**>>. Though if verbs do not exhibit semantic types from above Level Two, one might wonder if even appeal to Level Three *functional* vocabulary reflects imposition of Fregean typology on Slangs (as opposed to an independently attractive hypothesis). So one might look for alternatives to positing morphemes of type <*e***t**, <e, *e***t**>> or <e**t**, <e**t**, **t**>>.

3.2 Minimal Relationality

Consider (53), whose meaning might initially be specified with (53a) or (53b).

(53) A cat arrived.

(53a) ∃e[Past(e) & ∃x[Cat(x) & ArrivalOf(e, x)]]

(53b) ∃e:Past(e)[∃x:Cat(x)[ArrivalOf(e, x)]]

Neither specification seems quite right, given the permissive characters of '&' and '∃'. Recall that the Tarski-style ampersand can connect open sentences of any adicity, and the adicity of the resulting conjunction can be higher than that of either conjunct, as in (14).

(14) Nx & [Pyz & Nw]

To be sure, there are also respects in which Slangs go beyond a Tarski-style predicate calculus. But in searching for models of Slangs, one might look for a modest extension of a *fragment of* a Tarski-style language, as opposed to *supplementing* a language that already allows for (14) by adding denoters of truth values and higher-order functions.

Given lambda expressions, (53b) can be recoded as (53c),

(53c) **∃**:**Past**[λe.**∃**:**Cat**[λx.**ArrivalOf**(e, x)]]

with 'e' and 'x' as indices of abstraction. Relative to each assignment $\mathcal{A}$ of values to indices:

ArrivalOf(e, x) is a truth value—⊤ or ⊥, depending on whether or not $\mathcal{A}$(e) is an arrival of $\mathcal{A}$(x); λx.**ArrivalOf**(e, x) is a function that maps each entity to ⊤ if and only if $\mathcal{A}$(e) is an arrival of that entity; this function is mapped to ⊤ by the quantificational function **∃**:**Cat** if and only if some cat is such that $\mathcal{A}$(e) is an arrival of that cat; and likewise for the rest of (53c), which denotes ⊤ if and only if some event is an arrival of some cat. But this effect can be achieved with less power.

In (53c), 'λx' plays a dual role: it targets an index in the dyadic predicate; and it converts an expression of type <**t**> into an expression of type <e**t**>. In this latter respect, 'λx' is unlike '∃x' in (53a); it is also unlike '**∃**' and '**∃**:**Dog**' , neither of which can target either position in a dyadic predicate. With this in mind, imagine a language that allows for atomic sentences with one or two indexable positions—e.g., 'Cat(_)' and 'ArrivalOf(_, _)'—but no more.

One-placers are instances of a basic type <M>; two-placers, which permit expression of dyadic relations, are instances of a basic type <D>. There are no other types. And every complex expression of this language, Monadish, is an instance of type <M>. This language includes no lambda expressions. Strings like (53c) cannot be generated. Indeed, Monadish has no variables.

So adding lambdas wouldn't help, since strings like (14) are also ungenerable. Nonetheless, boundlessly many expressions of Monadish have dyadic consitutents.

The simplest combinatorial operation is "M-junction," via which two expressions of type <M> can be combined to form a third: 'Grey(_)^Cat(_)' applies to something if and only if both 'Grey(_)' and 'Cat(_)' apply to it. Fregean field semanticists might say that 'Cat(_)' indicates a function **C** of type <e**t**>; 'Grey(_)' indicates a function **G** of the same type; and 'Grey(_)^Cat(_)' indicates $\lambda x.\top$ if $\mathbf{G}(x) = \top$ **&** $\mathbf{C}(x) = \top$, and otherwise $\bot$. But this overintellectualizes. Expressions of type <M> are non-relational; like Tarskian sentences, they don't indicate functions. Put another way, the Fregean apparatus is an overly powerful for describing the I-language that speakers of Monadish acquire. That apparatus can also be used to describe a procedure according to which joining 'Grey(_)' to 'Cat(_)' forms a phrase that indicates a dyadic function: $\lambda y.\lambda x.\top$ if $\mathbf{G}(x) = \top$ & $\mathbf{C}(y) = \top$, and otherwise $\bot$. But by hypothesis, speakers of Monadish cannot understand 'grey cat' as an expression of type <D>.[13]

On the contrary, these speakers understand 'arrive cat' as an expression of type <M>, akin to the English 'arrival of a cat'. An expression of type <D> can combine with an expression of type <M>, via the operation "D-junction," which yields another expression of type <M>. Combining 'ArrivalOf(_, _)' with 'Cat(_)' with yields '∃[ArrivalOf(_, _)^Cat(_)]', which is understood in accord with the following constraints: the existential closure applies to the *monadic* predicate, which must be linked to the *second* position of the dyadic predicate. The mandatory construal is indicated in (54),

(54) ∃[ArrivalOf(_, _)^Cat(_)]

which is an analog of (54a) in a Tarski-style language that also generates (54b) and (54c).

(54a) ∃x[ArrivalOf(e, x) & Cat(x)]
(54b) #∃e[ArrivalOf(e, x) & Cat(x)]
(54c) #∃x[ArrivalOf(e, x) & Cat(y)]

But '∃[ArrivalOf(_, _)^Cat(_)]' is not disambiguated by inserting variables that reflect a choice of how to link the unsaturated positions in (54); the D-junction applies, unambiguously, to e if and only if e is an arrival of a cat.

If it helps, think of '∃' as skipping over 'Arrival(_, _)'—since neither position can be targeted by a variable-free closer—and think of the second position in 'Arrival(_, _)' as one that needs some link to independent content, since the first position is for events in which something arrives. In general, an instance of '∃[D(_, _)^M(_)]' applies to e if and only if e bears the dyadic relation to *something* that has the monadic property. So an expression of type <M> can have an atomic constituent of type <D> whose second position was restricted and closed via D-junction. This operation is a little more complex than M-junction, though still severely restricted to inputs of certain types, as opposed to the rather sophisticated operation of function-application that is associated with (R).[14]

(R) if <α> and <β> are types, so is <α, β>

[13] Likewise, humans cannot understand 'grey cat' as applying to pairs <x, y> such that x is grey and y is a cat.

[14] D-junction can viewed as a special case of Higginbotham's (1981) posited operation of *theta-marking*, which allowed for polyadicity. M-junction is the analog of what Higginbotham called *modification*.

In this context, it is worth remembering that 'a cat' may be of the same type as 'cat'; cp. Kamp (1981), Heim (1982). From a Fregean perspective, this seems odd. Why say that 'a cat' combines with 'arrive' in a conjunctive way that involves covert existential closure, instead of treating 'a cat' as a quantifier of type <e**t**, **t**>? But in languages without indefinite articles, the closure is covert either way. Moreover, (55) is understood as in (55a); cp. (56) and (57).

(55) see a cat arrive

(55a) ∃[SeeingOf(_, _)^∃[ArrivalOf(_, _)^Cat(_)]]

(56) Cats saw dogs arrive.

(57) Water fell on rocks.

So it isn't obvious that in (55), 'a' signifies existential closure; see also Higginbotham (1987).

Slangs may exhibit more semantic typology than Monadish. But the point is that Monadish is a model for how a language can allow for a minimal degree of relationality—*viz.*, locally bounded dyadicity—without generating expressions of Fregean types. I have argued elsewhere that the usual range of textbook examples, along with various puzzling cases, can be plausibly accommodated in these terms; see Pietroski (2005, 2014, 2017). But there is ample room for other models. Consider Dyadish, which admits atomic expressions of a third type—exhibited by atomic open sentences like 'ChaseByOf(_, _, _)'—and generates complex expressions of type <D>. Though if children acquire languages that are more like Monadish than Frege's *Begriffsschrift*, perhaps semanticists should try to supplement spare models, instead of trying to limit powerful ones. If plausible analyses of specific constructions cannot be plausibly recoded in terms of the types <M> and <D>, that is evidence that Slangs generate expressions of other types, but not yet evidence for a Fregean alternative.

3.3 Eschewing Level Zero

Obviously, <M> and <D> are analogs of <e**t**> and <e, e**t**>. But <M> and <D> are *basic* types, not abstract types from Levels One and Two of a hierarchy that starts with <e> and <**t**>. Let's stipulate that Monadish does not permit denoters, of entities or truth values. It does, however, allow for proprietary predicates like 'Felix(_)', which applies to at most one thing. Monadish also allows for (58),

(58) Demonstrated(_)^∃['Felix'-Sound(_)^CalledWith(_, _)]

which would apply to entity e in context C if and only if e is both demonstrated in C and (properly) called with the sound of 'Felix'. These expressions have Fregean analogs of type <e**t**>. But the question is not whether Monadish has expressions of type <e**t**>; it doesn't. The question is whether Slangs have expressions of the basic Fregean types <e> and <**t**>.

I can't review here the many reasons for thinking proper nouns are *not* expressions of type <e>. But the history of this topic is one of considering alternatives. A quantificational analysis, *a la* Russell/Montague, would be attractive if phrases like 'a/the/every cat' are of type <e**t**, **t**>. Though as Quine (1963) suggested, in discussing 'Pegasus', predicative analyses have their own attractions. Burge (1973) and Katz (1994) offer insightful proposals that can be formulated in Monadish-friendly terms. Deictic pronouns and traces of displacement can also be described as instances of type <M>; see Pietroski (2014, 2017). One can easily imagine a language that forbids expressions like (59).

(59) The three Tylers at the party included that nice Professor Tyler Burge.

So if kids *could* become adults who treat 'Tyler' as an instance of type <e>, why don't they?

Of course, describing 'Tyler' as an instance of type <e**t**> does not avoid appeal to the Fregean types <e> and <**t**>. But if we don't need the Fregean hierarchy of types, perhaps we can eschew <e> in favor of <M>. Eschewing appeal to <**t**>, as a semantic type, is also pretty easy.

Tarski showed how to describe true/false sentences as those satisfied by all/no sequences. And if we only have to worry about monadic predicates, we can posit a pair of operators—⇑ and ⇓—that combine with expressions of type <M> to form "polarized" predicates of the same type. For any expression '…' of type <M> and any entity e: '⇑…' applies to e if and only if '…' applies to something; '⇓…' applies to e if and only if '…' applies to nothing. If there is at least one cat, then '⇑Cat(_)' applies to each thing in the domain, and '⇓Cat(_)' applies to nothing. If the domain is catless, then '⇑Cat(_)' applies to nothing, and '⇓Cat(_)' applies to each thing. Thus, '⇑Cat(_)' and '⇓Cat(_)' are like 'such that there is a cat' and 'such that there is no cat'. Truth tables can be reconstructed in these terms. So we can do without <**t, t**> and <**t**, <**t, t**>>.

For each thing, the polarized predicate '⇑Past(_)^∃[ArrivalOf(_, _)^Cat(_)]' applies to it if and only if there was an arrival of cat; cp. 'such that a cat arrived'. And we can say that relative to any assignment $\mathcal{A}$ of values to indices '⇑Past(_)^∃[ArrivalOf(_, _)^1(_)]' applies to each thing or to nothing, depending on whether or not there was an arrival of whatever $\mathcal{A}$ assigns to the first index; cp. 'such that $\mathcal{A}$(1) arrived'. If indices can be devices of abstraction, as discussed above, then it is a small step to allowing for (60);

(60) 1-⇑Past(_)^∃[ArrivalOf(_, _)^1(_)]

where this clausal expression of type <M> applies to an entity e if and only if e is such that there was an arrival of e; cp. 'thing that arrived'.

This doesn't show that tensed expressions are *not* instances of type <**t**>. One can hypothesize that tense morphemes are restricted existential quantifiers of type <*e***t**, **t**>; cp. 'λΦ.∃*e*:Past(*e*)[**Φ**(*e*)]'. But on this view, a single morpheme does two very different jobs: it makes its own contribution as a temporal *restrictor* of an event predicate; and it *closes* that predicate, creating an expression of type <**t**>. But if 'a cat' need not be a restricted existential quantifier, why think that a tense (or aspect) morpheme is? One can treat tensed expressions as instances of type <e**t**> and posit a covert quantifier of type <*e***t**, **t**>. But then why not treat tensed expressions are instances of type <M> and posit a covert polarizer?

Partee (2006)—prompted by Carstairs-McCarthy's (1999) discussion of sentences and noun phrases—asked whether we to need to posit *two* basic semantic types. I share Partee's view that "tradition" explains much of the current reliance on appeals to type <**t**> in theories of meaning for Slangs. But I think that much the same can be said about reliance on appeals to type <e>. Frege's reasons for taking his two "saturating" types as basic, and describing expressions of nonbasic types as "unsaturated," do not show that Slangs fit this mold. Tarski showed that a language can have name-like expressions that are not of type <e> and sentences that are not of type <**t**>. So in offering theories of Slangs, we should not assume that these human languages generate expressions of boundlessly many types—recursively characterized in terms of <e> and <**t**>—as opposed to a few basic types like <M> and <D>.

3.4 Level Three Revisited

Still, one might wonder: what's the alternative to describing overt quantifiers, like 'every' and 'most', as instances of type <e**t**, <e**t**, **t**>>? One suggestion is that they are expressions, of type <D>, which apply to ordered pairs of *sets of* things in the relevant domain. This may be no worse than invoking higher-order functions, and at least we could avoid specifying the meaning of 'every' in terms of truth values. But quantificational words can also be described as expressions that apply more directly to ordered pairs of the things quantified over, given plural quantification as discussed by Boolos (1998) and others.

Let's stipulate that for any entities e and e′, e is the "inner participant" of the ordered pair <e′, e>—a.k.a. {e′, {e′, e}}—whose "outer participant" is e′. Ordered pairs can meet various conditions, distributive and collective. For example, some pairs might be such that each of their inner participants is a cat, and their outer participants are three dogs. Given ordered pairs of things in a domain that includes the cats, every cat arrived if and only if some pairs meet the following three conditions: every one of their inner participants is one of their outer participants; their inner participants are the cats; and their outer participants are the things that arrived.

Moreover, recalling the discussion of conservativity, 'every cat' lets us ignore the noncats. We can encode the restricted character of the quantification by saying that determiners apply to ordered pairs of a very limited sort: outer participants must be inner participants, as if determiners indicate second-order *classifications*, as opposed to relations; the inner participants reflect an initial selection from the domain via some predicate like 'cat', while outer participants reflect a second selection via some predicate like 'arrived' from the restricted domain (i.e., the initial selection). Echoing Barwise and Cooper's (1981) idea that determiners live on their internal arguments, we can say that determiners apply to ordered pairs that are "inner-focused." But the suggestion is not that this generalization about Slangs reflects a special constraint on which *relations* determiners can indicate. The suggestion is rather that Slang determiners are analogs of some Fregean quantifiers that can be mimicked with second-order classification.

Given a general "outers must be inners" constraint on Slang determiner meanings, the meaning of 'every' can be specified with an *identity* condition. Every cat arrived if and only if some pairs are such that: their outer participants *are* their inner participants; their inner participants are the cats; and their outer participants arrived. There are various ways of converting this observation into a compositional semantics; see Pietroski (2005, 2017). But given a maximizing operator that converts 'Cat(_)' into the plural predicate 'TheCats(_)', Monadish permits '∃[Internals(_, _)^TheCats(_)]', which applies to ordered pairs whose internal participants are the cats. Encoding the condition that corresponds to a determiner's external argument is also easy if that argument is a sentential/polarized predicate of type <M>.

Relative to any assignment $\mathcal{A}$ of values to indices, the predicate 'such that t_1 arrived' applies to Felix if and only if $\mathcal{A}(1)$ arrived; so relative to a minimal variant of $\mathcal{A}$ that assigns Felix to the indexed trace, 'such that t_1 arrived' applies Felix if and only if Felix arrived. So given Tarski-style quantification over the assignment variants corresponding to a restricted domain of cats, the open sentence 't_1 arrived' can be used to specify the cats that arrived. This can be viewed as a special case of lambda abstraction. But appealing to this very special case—needed to accommodate relative clauses, whatever we say about quantification—is not tantamount to invoking Level Three abstraction in a Fregean language.

Recall that neither equinumerosity nor the second-order identity relation is conservative. But if determiners don't indicate second-order relations, we don't need to say that (61) and (62)

(61) $\lambda\Psi.\lambda\Phi.\ \Phi = \Psi$

(62) $\lambda\Psi.\lambda\Phi.\#\{x: \Phi(x)\} = \#\{x: \Psi(x)\}$

are less conceptually natural than (63), which specifies the function corresponding to 'most'.[15]

(63) $\lambda\Psi.\lambda\Phi.\#\{x: \Phi(x)\ \&\ \Psi(x)\} > \#\{x: \Phi(x)\} - \#\{x: \Phi(x)\ \&\ \Psi(x)\}$

[15] If seven of ten cats arrived, then most of the cats arrived; and correlatively, the number of cats that arrived exceeds the result of subtracting that number from ten—i.e., 7 > (10 –7). See Lidz. et. al. (2011) for evidence that speakers do understand 'most' in terms of cardinalities and subtraction.

While (61) and (62) are simple functions, neither corresponds to a condition that can be imposed on inner-focused ordered pairs of entities, which reflect predications-within-predications, as opposed to relations between predicates. By contrast, (63) is more complex, but it specifies a conservative relation. And we can say that some inner-focused ordered pairs of entities meet the ‘most’-condition if and only if the number of their external participants exceeds the result of subtracting that number from the number of their internal participants.

Appealing to meanings of type <e**t**, <e**t**, **t**>> is not the only game in town. On the contrary, it raises the question of why so many meanings of this type are not attested. More generally, appealing to (R) and the two basic Fregean types is neither inevitable nor desirable.[16]

(R) if <α> and <β> are types, so is <α, β>

Positing meanings of the Monadish types <M> and <D> may be enough.

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