Semantic Types: Two Is Better Than Too Many

Paul M. Pietroski(✉)

Rutgers University, New Brunswick, NJ 08091, USA
paul.pietroski@rutgers.edu

Abstract. In studies of linguistic meaning, it is often assumed that the relevant expressions exhibit many semantic types: <e> for entity denoters; <t> for truth-evaluable sentences; and the non-basic types <α, β> such that <α> and <β> are types. Expressions of a type <α, β>—e.g., <e, t> or <<e, t>, <<e, t>, t>—are said to signify functions, from things of the sort associated with expressions of type <α> to things of the sort associated with expressions of type <β>. On this view, children acquire languages that are importantly like the language that Frege invented to study the foundations of arithmetic. I think this conception of human linguistic meaning overgenerates wildly, even distinguishing—as we should—competence from performance. I sketch an alternative, defended elsewhere, to illustrate a broader point: when offering theories of natural languages, we shouldn't be surprised if vocabulary designed for other purposes is inadequate, and attention to relevant phenomena motivates a spare semantic typology.

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1 Introduction

It seems obvious that 'dog' and 'cat' have distinct meanings that are somehow instances of the same type, while 'dog' and 'every' have meanings of different types. Likewise, it seems obvious that 'every brown dog' and 'some gray cat' have distinct meanings of the same type, but not so for the meanings of 'every brown dog' and 'barked at noon'. Though even if we assume that words and phrases have meanings that exhibit various semantic types, it isn't clear which taxonomy we should adopt when offering theories of meaning for the spoken or signed languages that human children naturally acquire. For various reasons, it has become common to assume that these languages are like Frege's [14–16] invented language—his *Begriffsschrift*—whose expressions exhibit endlessly many semantic types that can be characterized recursively in terms of truth and denotation. I advocate a sparer typology. But my main point is methodological: if the goal is to describe natural phenomena, we should posit semantic types cautiously.

1.1 Some Terminology and Background

Humans regularly acquire languages of a special sort. These languages—let's call them Slangs—have expressions that may be spoken or signed. These expressions are also

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meaningful, syntactically structured in distinctive ways, and generable by creatures like us. So let's think of Slangs as expression-generating procedures; cp. Chomsky's [9] talk of "I-languages," which is implicit in his earlier [4–7] characterization of syntactic structure in terms of how strings of "formatives" can be derived via certain generative procedures. If we adopt the idealization that for each Slang, there is a set whose elements are all and only the expressions generated by that Slang, then we can say that each Slang determines a set of expressions that is an "E-language" in Chomsky's sense. In principle, distinct I-languages might generate the same expressions. But there may be no actual examples of Slangs that are extensionally equivalent in this sense.

It can be useful, heuristically or pedagogically, to start with a conception of languages as sets of expressions. Though like most words, 'language' is polysemous. So theorists should be open to describing Slangs as procedures that can be biologically instantiated, instead of insisting that English is a set of strings; cp. [24, 25]. One can choose to focus on the sets that are the alleged extensions of Slangs. But like Chomsky, I don't think these sets constitute an interesting domain of inquiry; and I don't think it's explanatory to describe them, along with extensions of various invented procedures, as special cases of languages in a broad sense. In any case, my focus is on Slangs and the human capacity to acquire and use these procedures, which generate expressions that are meaningful and pronounceable in ways that invite empirical investigation.[1]

I assume that the expressions generated by a Slang connect meanings of some kind with pronunciations that are associated with vocal or manual gestures. This leaves room for debate about what pronunciations (or "phonological interpretations") are, and how they are related to (i) perceptible events like acoustic vibrations or bodily movements and (ii) the capacities/representations that speakers use to produce and classify such events. Likewise, theorists can disagree about how the meanings in questions are related to shared environments and human psychology. But whatever these meanings are, Slangs connect them with pronunciations in human ways.

These ways of connecting meanings with pronunciations allow for endlessly many examples of homophony, subject to substantive constraints. The constraints are valuable clues for inquirers trying to discover which types Slang expressions exhibit. In this context, I want to review some familiar points that are often ignored.

The pronunciation of 'bank' (a.k.a. /bæŋk/) can be used to express more than one word meaning, and likewise for the pronunciation of 'drew' (a.k.a. /dru/). Put another way, the lexical items of English include some homophones that link their distinct meanings to /bæŋk/ and some homophones that link their distinct meanings to /dru/. So

[1] Thomason [32] urged a different project in which linguistics—or at least studies of syntax and semantics—would be developed as a branch of mathematics ("Montague Grammar"), without focusing on properties of human languages/procedures that are "merely psychologically universal." But as Chomsky remarks [8, pp. 29–30], if the envisioned enterprise is to be evaluated in terms of the interesting theorems that have emerged, it hasn't been a great success; and one wouldn't expect to find mathematicians (e.g., David Hilbert) describing physicists as being unduly concerned with the "merely physical" properties of the universe. Similarly, insisting on a "general semantics" that covers Slangs and also sundry invented languages that meet certain stipulated conditions (see [24]) may be like insisting on a "general biology" that is not limited to living things but also covers logically possible animals like unicorns and dragons. Such a project might lead to describing actual animals in ways that are less than ideal for purposes of actual biology.

the pronunciation of (1) is shared by at least four strings of lexical items that correspond to the four sentence meanings indicated with (1a–1d), in which superscripted symbols are used to distinguish homophonous lexical items.

$$\textit{a sheriff drew his gun near the bank} \tag{1}$$

A sheriff near a $^{\$}$bank $^{☜}$drew a gun. (1a)

A sheriff near a $^{≋}$bank $^{✎}$drew a gun. (1b)

A sheriff near a $^{\$}$bank $^{☜}$drew a gun. (1c)

A sheriff near a $^{≋}$bank $^{✎}$drew a gun. (1d)

There are finitely many cases of lexical homophony.[2] But as Chomsky [4, 6] stressed, there are endlessly many cases of constructional homophony. For example, ‘an aim’ and ‘a name’ have the same phonological formatives. So larger phrases like ‘horse with an aim’ and ‘horse with a name’ pair their distinct meanings with a shared pronunciation. Moreover, a single string of lexical items can be comprehensible in distinct ways that correspond to distinct sentential meanings. Consider string (2), which can be understood in the three ways indicated with (2a–2c).

a woman saw a man reading in the library (2)

A woman saw a man who was reading in the library. (2a)

A woman saw a man do some reading in the library. (2b)

A woman saw a man while she was reading in the library. (2c)

These three meanings reflect different ways of combining the lexical items in (2)—and more specifically, the ways in which ‘reading in the library’ can combine with ‘man’, ‘a man’, or ‘saw a man’. Though for present purposes, the details are less important than the point that examples of homophony provide anchors for talk of meanings.

Whatever meanings are, three of them can be expressed with string (2). By contrast, string (3) has only the meaning indicated with (3b).

this is the library a woman saw a man reading in (3)

[2] And they are usually arbitrary. The meanings expressed with /bæŋk/ could be expressed, as in many languages, with lexical items that have distinct pronunciations. The polysemous word ‘window’ seems to have a meaning that supports related “subsenses,” which can be used to talk about certain openings in walls or framed panes of glass that fill such openings. But even if polysemy is open-ended, the number of subsenses is presumably finite for each speaker.

This is the library such that a woman saw a man who was reading in it. # (3a)

This is the library such that a woman saw a man do some reading in it. (3b)

This is the library such that a woman saw a man while she was reading in it. # (3c)

Neither (3a) nor (3c) can be used to paraphrase an available "reading" of (3). Similarly, while (4) can be understood in two ways that we might indicate with 'ready to dine' and 'fit to be eaten', (5) and (6) are unambiguous; cp. 'eager to dine' and 'easily eaten'.

the duck is ready to eat (4)

the duck is eager to eat (5)

the duck is easy to eat (6)

So even if we initially describe languages as sets of grammatical strings of lexical items, a good specification of what a Slang generates must specify all and only the relevant pronunciation-meaning (π-μ) pairs. Given a list of lexical items, it's easy to describe a procedure that generates every string—and hence, every meaningful string—that can be formed from these items. But if some such procedure generates (3) and (4), it will also generate gibberish like (7) and (8).

this a reading the is saw library a in woman man (7)

eat to is duck the ready (8)

Moreover, suppose we discovered a procedure that generates all and only the sentential strings of English words. Since endlessly many of these strings are homophonous, we would want to know why each of them has the meaning or meanings that it has, but no others. As we'll see, this can motivate appeal to a semantic typology that limits the candidate lexical and phrasal meanings.

1.2 Slangs: Descriptions and Explanations

For any given Slang, S, specifying a procedure that generates all and only the π-μ pairs generated by S would be a monumental task. But this is not a license for inquirers to focus on this task and ignore how Slangs generate π-μ pairs. One can't stipulate that the primary—initial, or any—scientific task in this vicinity is to specify grammars that are extensionally equivalent to Slangs. There may not be an independently specifiable notion of extensional equivalence, much less one that is illuminating. Moreover, when characterizing Slangs, inquirers need to balance the goals of describing attested π-μ pairs and explaining the absence of alternatives; cp. Chomsky's [6, 7] discussion of adequacy conditions for proposed grammars. There are several related points here.

First, we don't know what meanings are. So in assessing whether or not a proposed model of a Slang pairs certain sentential strings with interpretations of the right sort—truth values, sets of worlds, structured propositions, mental representations of some kind, or whatever—we should consider insights obtained from attempts to model how Slangs generate what they generate.[3] Second, even if we adopt a particular conception of meanings and assume that each Slang determines a certain set of π-μ pairs, proposed models won't determine this set. Extensional inadequacy will be the norm for the foreseeable future, at least with regard to many details. But absent reasons for thinking that some proposed procedures are on the right track, we have no clear sense of what it is for models to have extensions that are roughly equivalent to a target set with boundlessly many elements not yet specified. Third, if the goal is to describe Slangs as the natural objects they are, we shouldn't restrict attention to π-μ pairs that are actually produced; probing in other ways, via designed experiments, may well be valuable. In general, we shouldn't arbitrarily prioritize observations of any kind. As in other domains on inquiry, we have to discover what is theoretically important.[4]

Describing Slangs as procedures that generate certain π-μ pairs is certainly useful, and for many purposes, more productive than describing Slangs as cognitive resources that have a certain biologically instantiated recursive character that we don't yet understand. But we shouldn't conclude that the essential properties of Slangs are captured by any extensionally equivalent procedures, and that describing "further" properties of Slangs is theoretically optional. If the goal is to describe Slangs, and not merely to mimic their alleged extensions, then descriptive adequacy seems to require far more than extensional equivalence—especially if we tentatively assume a particular conception of sentence meanings (e.g., as mappings from contexts to sets of worlds).

For example, just as speakers have intuitions regarding how pronunciations are related—think of rhyme and alliteration—they have analogous intuitions regarding meanings. Chomsky [4, 6] highlighted question-answer pairs like (9) and (10).

can the birds that sing softly fly fast (9)

the birds that (do) sing softly can fly fast (10)

Note that (9) cannot be understood as the yes-no question corresponding to (11).

the birds that can sing softly (do) fly fast (11)

Declarative sentences also seem to exhibit relations of implication. Consider (12–15).

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[3] For example, if π-μ pairs are generated in structure-dependent ways involving transformations (but no context-sensitive operations of inversion), that is relevant; see, e.g., [4–6].

[4] One can define a task of describing certain facts (e.g., those concerning apparent motions of celestial bodies from a certain vantage point) without regard to other facts (e.g., those concerning the motions of terrestrial pendula and balls rolling down inclined planes, or correlations between tides and phases of the moon). But whatever the value of such tasks, they shouldn't be confused with the goal of explaining natural phenomena. History suggests that this goal is hindered by trying to define the relevant explananda in advance, but that when studying Slangs, it's easy to slide into behavioristic stipulations that restrict attention to data that is accessible in certain ways.

a red bird sang proudly (12)

a bird sang proudly (13)

a red bird sang (14)

a bird sang (15)

Prima facie, (12) implies (13) and (14), each of which implies (15). But the conjunction of (13) and (14) doesn't imply (15); see, e.g., [13, 33]. This pattern is systematic and exhibited by examples like (16–19), despite the Carrollian nouns, verbs, and modifiers.

a slithy tove gimbled in the wabe (16)

a tove gimbled in the wabe (17)

a slithy tove gimbled (18)

a tove gimbled (19)

So just as an adequate grammar for English mustn't overgenerate meanings for (9), it mustn't overgenerate implications for (12–15). Of course, examples like (20)—which implies neither (21) nor (22)—must also be accommodated.

a fake diamond was allegedly stolen (20)

a diamond was allegedly stolen (21)

a fake diamond was stolen (22)

But if the task is to describe Slangs and what they generate, then examples like (12–19) tell against the hypothesis urged by Lewis [24]: intuitions of implication reflect what speakers know about specific lexical meanings (e.g., 'red' and 'proudly', as opposed to 'fake' and 'allegedly'); 'bird' and 'red bird' are not instances of logically related types, much less types in virtue of which the grammatical modifier 'red' is understood to be restrictive; likewise for 'sang' and 'sang proudly'. Instead of generalizing from (20–22) in this apparently retrograde way, we can these cases as special despite their superficial similarity to (12–14).[5]

Put another way, it's not enough for a theory to associate the pronunciations of (12–14) with sets of worlds Σ^{12}, Σ^{13}, and Σ^{14} such that Σ^{13} and Σ^{14} are non-exhaustive subsets of Σ^{12}. If competent speakers understand the modifiers in (12) as restrictive, then a descriptively adequate grammar needs to account for this. More generally, such a

[5] Compare 'easy/eager to please' and 'persuaded/expected John to leave'; see [6, 7]. Note that 'I persuaded him that he should leave' is fine, unlike 'I persuaded that he should leave'. But 'I expected that he would leave' is fine, unlike 'I expected him that he should leave'.

grammar has to generate the right π-μ pairs in the right way. If this requires deriving the π-μ pair corresponding to the interrogative (9) as a transformation of the π-μ pair corresponding to (10), then there is no point in pretending otherwise by defining some weaker notion of adequacy. Similarly, if (12) is understood as some kind of existential generalization akin to (12a), then there is no point in pretending otherwise.

$$\exists x \exists e[Bird(x)\ \&\ Red(x)\ \&\ PastSingingBy(e,x)\ \&\ DoneProudly(e)] \quad (12a)$$

Examples like (23)—which can be understood as (23a) or (23b), but not as (23c)—provide independent support for Davidsonian event analyses.

a boy saw a man with a spyglass (23)

A boy saw a man who had a spyglass. (23a)

A boy saw a man by using a spyglass. (23b)

A boy saw a man and had a spyglass. # (23c)

The string 'saw a man with a spyglass' can be grammatically structured in two ways that correspond to (23a) and (23b), which can be regimented as (23a') and (23b'), with 'PSBO' abbreviating the semantically triadic predicate 'PastSeeingByOf'.

$$\exists e \exists x \exists y[Boy(x)\ \&\ PSBO(e,x,y)\ \&\ Man(y)\ \&\ Had\text{-}A\text{-}Spyglass(y)] \quad (23a')$$

$$\exists e \exists x \exists y[Boy(x)\ \&\ PSBO(e,x,y)\ \&\ Man(y)\ \&\ Done\text{-}With\text{-}A\text{-}Spyglass(e)] \quad (23b')$$

But this highlights the question of why human speakers of English cannot understand (23) as having the unattested meaning (23c), which can be regimented as (23c').

$$\exists e \exists x \exists y[Boy(x)\ \&\ PSBO(e,x,y)\ \&\ Man(y)\ \&\ Had\text{-}A\text{-}Spyglass(x)] \quad (23c')$$

If the meaning of the verb is semantically triadic, we want to know why (23) has the two meanings it does have, as opposed to others. One suggestion is that while the verb meaning is eventish, it turns out to be semantically dyadic in the way indicated with regimentation (23b''), where 'PSO' abbreviates 'PastSeeingOf'; see [28], drawing on [21, 29, 30] among others.

$$\exists x \exists e \exists y[Woman(x)\ \&\ AgentOf(e,x)\ \&\ PSO(e,y)\ \&\ Man(y)\ Had\text{-}A\text{-}Spyglass(y)] \quad (23b'')$$

But if this is correct, it highlights the question of why speakers fail to understand 'see' triadically. (As usual, and as desired, replies beget queries.)

One possible answer is that speakers acquire particular grammars in accord with a Universal Grammar that precludes supradyadic expressions, including any of the Fregean type <e, <e, <e, t≫>; see [28] for elaboration and defense. Of course, one can reject any such proposal and say that at least in principle, verbs can be triadic, tetradic, pentadic, etc. But this is also a hypothesis about Slangs, as is the claim that human Universal Grammar doesn't preclude expressions of type <<e, <e, t≫, <<e, t>, t≫.

In short, a fact about (23)—viz., that it is two but not three ways ambiguous—can, perhaps surprisingly, be germane to questions concerning the semantic typology of Slang expressions. More generally, for any given Slang, theorists face the task of formulating a grammar that generates the right π-μ pairs without overgenerating; and once we consider relations of implication, it becomes clear that there are many ways to overgenerate. Upon reflection, this highlights the real task of describing the procedures that humans actually acquire as examples of the "internalized grammars" that we can naturally acquire, given ordinary courses of experience, by virtue of having an innate endowment that lets us acquire and use expression-generating procedures of a certain sort. And to carry out this task, we need to discover the relevant sort; see Chomsky [7].

We can't stipulate that Slangs are procedures of a kind that suits the purposes of logicians. Likewise, we can't stipulate that Slangs connect pronunciations with meanings of Fregean types. We don't know what meanings are, and so unsurprisingly, we don't know what types they exhibit. But one familiar idea is very implausible.

2 Unwanted Recursion

Given at least one semantic type, the recursive and Fregean principle (RF) implies that there are boundlessly many such types.

$$\text{if } \langle\alpha\rangle \text{ and } \langle\beta\rangle \text{ are types, so is } \langle\alpha, \beta\rangle \qquad \text{(RF)}$$

This might seem innocuous, given that a Slang can generate endlessly many π-μ pairs in the (innocuous) sense that a finitely specified theory can generate endlessly many theorems. But while any expression of English can be part of another, even though there are limits on the size of expressions that can actually be produced by human minds, it doesn't follow there are endlessly many *types* of expressions or expression meanings. On the contrary, given available evidence regarding constraints on how Slangs generate what they generate, I think we should be deeply skeptical of (RF) and try to replace it with an account that posits a small number of semantic types —perhaps as few as two.

2.1 Apparent Overgeneration[6]

It's worth noting that given two basic semantic types, just a few iterations of (RF) yields many, many more. Consider, in the usual way, an initial domain consisting of some entities (e.g., the natural numbers) and two truth values, T and ⊥.

Given such a domain, we can say that <e> and <t> are 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

[6] Some of this section is drawn, with slight modifications, from [27] and [28].

Level Zero sort to things of some Level Zero sort. Put another way, Level Zero is exhausted by the two basic types <e> and <t>, which can be described as <0> types. Level One is exhausted by the four <0> types. The next level includes all and only 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 class of functions. (Compare the "iterative conception" of the Zermelo-Frankl sets, as discussed by [B].)

At Level Three, there are the 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 the Fregean type <<e, <e, t>>, <e, <e, t>>>. Level Four has 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. Let's not worry about Level Five, at which there are more than 5×10^{12} types.

My concern is not merely that endlessly many Fregean types, including the vast majority of those below Level Five, are unattested in actual Slangs. I grant that endlessly many types are too abstract for our limited memories, and that many types like <t, <e, <t, e>>> correspond to functions that we wouldn't want words for. But as Frege showed, some of the types at Levels Three and Four seem fine.

Let 'et' abbreviate '<e, t>' and consider the Level Three type <<e, et>, t>. Expressions of type <e, et> indicate functions like λy.λx.Predecessor(x, y)—i.e., λy.λx.T if x is the predecessor of y, and ⊥ otherwise; such functions map entities onto functions from entities to truth values.[7] Expressions of type <<e, et>, t> thus indicate functions that map functions like λy.λx.Predecessor(x, y) onto truth values. Frege showed how to use such expressions to encode judgments about certain properties of first-order dyadic relations. For example, λy.λx.Predecessor(x, y) isn't transitive, but λy.λx.Precedes(x, y) is. This judgment can be encoded with (24).

$$\sim \mathbf{TRANS}[\lambda y.\lambda x.\mathbf{Predecessor}(x, y)] \,\&\, \mathbf{TRANS}[\lambda y.\lambda x.\mathbf{Precedes}(x, y)] \qquad (24)$$

Fregean languages also support abstraction over relations. The function λD.TRANS(D) maps λy.λx.Precedes(x, y) to T and λy.λx.Predecessor(x, y) to ⊥. Correlatively, one can encode relational thoughts about relations—e.g., the thought that precedence is the transitive closure (or "ancestral") of the predecessor relation—in a logically perspicuous way, instead of using phrases like 'the predecessor relation' and

[7] Hence, **Predecessor**(2, 3) is a truth value, even if 'Predecessor(3)' denotes a number. Likewise, **Prime**(2) is a truth value, even if 'Prime(2)' does not denote a truth value but instead has a Tarskian satisfaction condition. In this sense, expressions of type <e, t> are relational, even if they also count as monadic; they indicate mappings from entities to truth values, highlighted here with boldface. In this sense, λx.Predecessor(x) and λx.**Prime**(x) are on a par with regard to arity/adicity. If only for simplicity, I ignore Frege's [16] talk of Functions/Concepts being *unsaturated* and use lambda expressions to talk about denotable functions as in [12].

nominalizations like ‘precedence’. Indeed, as Frege showed, the real power of his logic is revealed with expressions of the Level Four type <<e, et>, <<e, et>, t>> as in (25).[8]

$$\mathbf{ANCESTRAL{-}OF}[\lambda y.\lambda x.\mathbf{Precedes}(x, y), \lambda y.\lambda x.\mathbf{Predecessor}(x, y)] \tag{25}$$

Frege thought he was offering a novel way of representing relations among relations. He thought he had to invent a new kind of language to allow for sentences with constituents of type <<e, et>, <<e, et>, t≫. But one can hypothesize that Slangs already allow for expressions of types <e> and <t>, and that our linguistic competence supports acquisition of words that exhibit more abstract types as characterized by (RF).

$$\text{if } <\alpha> \text{ and} <\beta> \text{ are types, so is } <\alpha,\ \beta> \tag{RF}$$

In which case, perhaps our capacities to acquire and combine words support generation of sentences like (24) and (25), which might be pronounced like (24a) and (25a); where ‘transit’ and ‘ancest’ would be words of types <<e, et>, t> and <<e, et>, <<e, et>, t≫.

Predecessor doesn't transit, but precede transits. (24a)

Precede ancests predecessor. (25a)

But if this brave hypothesis is correct, one wants to know why humans don’t—and apparently can’t—acquire such words.

One can say that we lack the cognitive resources needed to abstract and store expressions of certain types. As an analogy, one might note that the grammatical and not especially long sentence ‘the rats the cats the dogs chased chased ate the cheese’ sounds like gibberish, presumably because memory limitations make it impossible for us to parse multiple center embeddings; cp. [4, 11]. But my concern is not that merely that some coherent Fregean types below Level Five seem to be unavailable as semantic types. My worry is more is that humans can, and with a little help often do, grasp the thoughts indicated with formalism like (24) and (25). So why can’t we pronounce these thoughts directly, with words like ‘transits’ and ‘ancests’, if Slangs permit expressions of types like <<e, et>, t> and <<e, et>, <<e, et>, t≫? These types don’t seem especially arcane, or hard to grasp, compared to <e, et> and <et, <et, t≫.

2.2 Ungrammatical Abstraction

Here is another way of indicating the concern, drawing on [3]. Relative clause abstraction on the subject or object of (26), as in (27–28), is easy. So why isn’t (29) equally available, with the italicized phrase construed as a relative clause of type <<e, et>, t>?

[8] Note that the function λ**D′**.λ**D**.**ANCESTRAL-OF**(**D**, **D′**) is like λ**D**.**TRANSITIVE**(**D**) in being second-order, but also like λy.λx.**Predecessor**(x, y) in being dyadic. By contrast, the function λ**D**. ANCESTRAL(**D**) maps λy.λx.**Predecessor**(x, y) to λy.λx.**Precedes**(x, y).

the plate outweighs the knife (26)

the plate is something which outweighs the knife (27)

the knife is something which the plate outweighs (28)

**outweighs is something which the plate the knife* (29)

One can say that ‘something’ or ‘which’ imposes a type restriction. But then why can’t we have a type-appropriate analog like ‘somerelat whonk the plate the knife’? And why can’t we use ‘Precedes is something that three four’ to convey, perhaps in a grammatically imperfect way, that λy.λx.Precedes(x, y) is a relation that three bears to four?

Similar questions arise with regard to quantificational determiners. It is often said that words like ‘every’ and ‘most’, as in (30), are instances of type <et, <et, t≫.

every dog saw most of the cats (30)

The familiar 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 transitive verb can combine with two arguments of type <e>. In explaining this idea to students, one might say that the types <e, et> and <et, <et, t>> are both instantiations of the abstract pattern <α, <α, t>>. But so is <<e, et>, <<e, et>, t>>. So if some human words are of type <e, et>, and the space of possible Slang semantic types is characterized by (RF), what precludes words of type <<e, et>, <<e, et>, t>>? Even if *verbs* cannot be examples of this type, one wants to know why humans can’t naturally use Slangs to form expressions like (31); where ‘Ancestral predecessor’ is a complex constituent of type <<e, et>, t>.

Ancestral predecessor precede (31)

This bolsters other reasons for suspecting that phrases like ‘every dog’ are not instances of the Fregean type <et, t>. One difficulty for this view is that (32) cannot be understood as an expression of type <t> according to which every dog barked today.

every dog which barked today (32)

But if ‘which barked today’ is of type <e, t>, why can’t it combine with ‘every dog’ to yield the following sentential meaning: every dog (is one which) barked today? Why is (32) unambiguous and understood only as a quantifier in which ‘dog’ is modified by the relative clause? One can say that for some syntactic reason, ‘every’ cannot take a relative clause as its external argument and must instead combine with a smaller clause of the same semantic type. But the issue runs deeper.

We can specify the meaning of (32) as follows: for every dog, there was an event of it barking today. And we can posit a syntactic structure in which ‘every dog’ raises, leaving a trace of displacement, so that the external argument of ‘every’ is a sentential expression akin to ‘it barked today’. But if such an expression is of type <t>, then we need another assumption to maintain that ‘every’ is of type <et, <et, t≫.

Heim and Kratzer [18] are admirably explicit about this. On their view, (32) has the form shown in (32a), with the indexed trace interpreted like a bound pronoun.

$$\left[\left[\text{every}_{<et,<et,t>} \text{ dog}_{<et>}\right]_{<et,t>} \left[1\left[t_1 \text{barked today}\right]_{<t>}\right]_{<et>}\right]_{<t>} \quad (32a)$$

The bare index is a syncategorematic element that combines with the original sentence, thereby converting an expression of type <t>—from which ‘every dog’ has moved—into an expression of type <et>.[9] Like Heim and Kratzer, I think we need to posit a syncategorematic operation of abstraction, corresponding to Tarski-style quantification over ways of assigning values to indices; see [28]. So my concern is not that they posit indices that are not instances of a Fregean type. But I do worry that (32a) posits an element that effectively converts the external/sentential argument of ‘every’ into a relative clause, thereby effacing the contrast with the internal/nominal argument, even though quantificational determiners cannot take relative clauses as external arguments.

Given that (32) cannot be understood as a sentence, it seems odd to say that (32a) is the grammatical form of a sentence in which ‘every dog’ combines with an expression whose meaning is that of the relative clause ‘which barked today’. One can insist that ‘every’ abhors relative clauses, yet still maintain that (i) ‘every’ indicates a relation that is exhibited by functions of the sort indicated with relative clauses, and (ii) the apparently sentential argument of ‘every’ gets converted into something that looks like a relative clause. But even if this position is coherent, it seems strained.

With these points in mind, let’s return to the absence of expressions that would exhibit the Level Four type <<e, et>, <<e, et>, t>>. Perhaps some cognitive limitation inhibits abstractions like λ**D′**.λ**D**.**ANCESTRAL-OF**(**D**, **D′**) without precluding expressions of types like <et, <et, t>> and <e, et>. But even if this ancillary hypothesis is correct, the Level Four types also include <et, <et, <et, t>>>> and <e, <e, <e, <et>>>>.

If these types are also unattested in Slangs, one wants to know why. It’s not hard to imagine triadic determiners like ‘trink’, which could combine with three monadic predicates as in (33) to yield a meaning like that of (33a) or (33b).

trink dogs cats are brown (33)

The brown dogs outnumbered the brown cats. (33a)

There are some brown dogs or brown cats. (33b)

9 The index is not posited as an expression of type <t, et>; but neither is the displaced element in $[\text{which}_1\ [t_1 \text{ ran quickly}]_{<t>}]_{<et>}$. 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 **T** iff S denotes **T** relative to the minimally different assignment A* that assigns e to *i*.

It's even easier to imagine "tri-transitive" verbs that could appears in sentences like (34), with the following meaning: a man sold a woman a car for a dollar.[10]

$$\textit{a man sald a woman a car a dollar} \tag{34}$$

We can, it seems, form a concept of selling whose adicity exceeds that of a corresponding concept of giving. A seller gets something back as part of the exchange. So why can't we introduce a semantically tetradic verb, akin to the concept SOLD(X, Y, Z, W)? Why do we need prepositional phrases like '*for* a dollar' if verbs can be of instances of the Fregean type <e, <e, <e, <et>>>>?

2.3 The Initially Plausible Eight

One can speculate that some cognitive limitation precludes expressions of any semantic types from above Level Three. But if the number of plausibly attested types is small, why appeal to (RF) and the requisite performance limitations, as opposed to a short list?

$$\text{if } \langle\alpha\rangle \text{ and } \langle\beta\rangle \text{ are types, so is } \langle\alpha,\ \beta\rangle \tag{RF}$$

One might start with <e> and <t> from Level Zero; <e, t> and <t, t> from Level One; <e, et> and <et, t> from Level Two; <e, <e, et>> and <et, <et, t>> from Level Three. Perhaps there are good empirical reasons for adding a few more. But there are also motivations for shortening this initial list of eight semantic types.

We've already seen some reasons for doubting that quantificational determiners like 'every' are instances of type <et, <et, t>> and that phrases like 'every dog' are instances of type <et, t>.[11] With regard to <t, t>, it can be tempting to analyze the negations in 'is not red' and 'may not be red' as sentential. But such analyses are not attractive empirically; see [19, 22]. Given [31], one can eschew appeal to truth values and <t> as a semantic type—treating closed sentences as predicates that are satisfied by everything or nothing—unless <t> is needed to introduce higher types via some principle like (RF); see [26] for related and helpful discussion. So instead of describing monadic/dyadic/triadic predicates in terms of relations to truth values, one might simply posit basic types <M>, <D>, and <T>. Complete sentences can be described as "polarized" expressions that are special cases of type <M>; see [28].

This provides independent motivation for describing proper nouns as special cases of nouns that are instances of type <M>, as opposed to expressions of a special type <e>. In my view, predicative conceptions of names are both viable and attractive; see,

[10] For these purposes, let's not worry about the indefinite descriptions. Suppose that 'sald' would be of type <e, <e, <e, <et>>>> and not the Level Five type <et, <et, <et, <et, t>>>>. For these purposes, let's also ignore adverbial modification and the need for an event variable.

[11] See [28] for further discussion, a treatment of quantificational determiners as plural monadic predicates, and the puzzles presented by "conservativity" if we say that words like 'every' and 'most' express second-order relations exhibited by first-order monadic predicates.

e.g., [2, 17, 20, 21]. More generally, I think there are very few reasons—apart from habit and convenience—for positing <e> or <t> as semantic types.

It's less controversial that we can and probably should do without appeal to semantically triadic predicates. In Sect. 1.2, I offered one reason for eschewing such predicates in connection with possible construals of (23).

a boy saw a man with a spyglass (23)

But to take a simpler example, children can presumably acquire triadic concepts like BETWEEN(X, Y, Z), FORMED-A-TRIO(X, Y, Z), etc. So if Slangs are relevantly like Frege's *Begriffsschrift*, one might have expected 'between' to indicate a triadic concept and appear in sentences like (35). But instead, we circumlocute and use (36), as if Slangs abhor lexical items of type <e, <e, et≫.

a cat betweens a dog a barn (35)

a cat is between a dog and a barn (36)

In light of [1, 10, 21, 23], the verbs in ditransitive constructions like (37)

a woman gave a dog a bone (37)

can be analyzed as dyadic predicates, as suggested by (38) and (39).

a woman gave a bone to a dog (38)

a bone was given to a dog by a woman (39)

So perhaps we should make do with appeal to monadic and dyadic predicates, taking these to be instances of two basic types, <M> and <D>. In [28], I show how to cover the usual range of textbook cases and more with this spare typology and some principles for constructing complex monadic concepts from a stock of initial concepts that are monadic or dyadic. The two basic principles are unsurprising: combining two expressions of type <M> yields a third that is understood as a conjunction; combining an instance of <D> with an instance of <M> yields an instance of <M> that corresponds to whatever *bears the dyadic relation to something* that meets the monadic condition.

Phrases, including 'a woman' and 'gave a dog a bone', can then be described as expressions that connect their pronunciations with monadic concepts whose constituents are monadic or dyadic; where these constituents include both representations of events and thematic relations like being-the-agent-of. Complete sentences and relative clauses can be described as special cases of using one expression of type <M> to make another, via grammatical operations that correspond to ways of constructing special (i.e., polarized or de-polarized) monadic concepts from simpler constituents. Perhaps to achieve descriptive adequacy, we will need to posit a few additional types and/or syncategorematic operations. But so long as the additions are minimal and plausibly constrained, this seems preferable to positing endlessly many types, only a few of which are needed or wanted. If the goal is to discover the semantic typology exhibited by Slang expressions, then we shouldn't start by assuming <e>, <t>, and (RF).

$$\text{if } <\alpha> \text{ and } <\beta> \text{ are types, so is } <\alpha, \beta> \qquad \text{(RF)}$$

Instead, we can start by asking which types seem to be independently motivated, and then ask how our initial list should be revised in light of further data and methodological reflection. If the net result is that we posit less as inquiry proceeds (cp. [10]), that is a good sign, not a cause for dismay.[12]

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