

Type Theory and Natural Language: Do We Need Two Basic Types?¹

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0. A universal, or almost universal distinction, in syntax: Sentence and NP

In a provocative book about language evolution² (Carstairs-McCarthy 1999), Andrew Carstairs-McCarthy argues that the apparently universal distinction in human languages between sentences and noun phrases cannot be assumed to be inevitable for languages with the expressive power of human languages, but needs explaining.

I will not discuss the question of whether the S-NP distinction is really universal; see (Arkadiev and Burlak 2004) for that. Much of that part of Carstairs-McCarthy’s book is at the level of thought experiments, directed against those who try, like Chomsky, to argue that the distinction is a necessary one, that a language could not serve the functions that natural languages serve so well without that distinction. I will also stay mostly at the level of thought experiments about what is in principle possible, although I will make use of existing analyses of existing linguistic phenomena in developing my arguments.

1. A possibly universal foundation for natural language semantics: types e and t

McCarthy’s work suggests that there is also no conceptual necessity for the distinction between basic types e and t, a distinction argued for by Frege and carried into formal semantics through the work of Montague (Montague 1970).

The types of Montague’s **IL** (Intensional Logic) are as follows:

Basic types: e (entities), t (truth values)

Functional types: If a, b are types, then $\langle a, b \rangle$ is a type (the type of functions from a-type things to b-type things.)

Intensional types: If a is a type, then $\langle s, a \rangle$ is a type (the type of functions from possible worlds to things (extensions) of type a.)

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² The book has been reviewed in *Voprosy Jazykoznanija* (Arkadiev and Burlak 2004).

Model structure for \mathbf{IL} : $\mathbf{M} = \langle \mathbf{D}, \mathbf{W}, \mathbf{I} \rangle$. Each model must contain:

A domain \mathbf{D} of entities (individuals)

A set \mathbf{W} of possible worlds (or possible world-time pairs, or possible situations)

\mathbf{I} : Interpretation function which assigns semantic values to all constants.

The domains of possible denotations for expressions of type a (relative to \mathbf{D}, \mathbf{W}) are defined recursively as follows:

$\mathbf{D}_e = \mathbf{D}$

$\mathbf{D}_t = \{0,1\}$

$\mathbf{D}_{\langle a,b \rangle} = \{f \mid f: \mathbf{D}_a \rightarrow \mathbf{D}_b\}$ (i.e. the set of all functions f from \mathbf{D}_a to \mathbf{D}_b .)

$\mathbf{D}_{\langle s,a \rangle} = \{f \mid f: \mathbf{W} \rightarrow \mathbf{D}_a\}$ (i.e. the set of all functions f from \mathbf{W} to \mathbf{D}_a .)

- Carstairs-McCarthy does assume **pragmatic** distinctions among various kinds of speech acts, including asserting, questioning, commanding, and pointing things out.
 - He does assume that there are expressions of functional types, and that function-argument structure is important in syntax and semantics.
 - What he questions is whether a syntacticized sentence-NP distinction is essential.
- Why have formal semanticists taken e and t as the two basic semantic types?
- In part because of tradition. Linguists are “consumers” of logic, not logicians.
 - In part because doing so worked well, although many would now add one or two more basic types, for *events* (or *situations*) and for *times*.
- About the model-theoretic content of the domains of types e and t :
- The model-theoretic domain corresponding to **type e** has been fairly uncontroversial, except in approaches which replace basic **set theory** with **property theory**, and posit an entity-correlate (“nominalization”) for (almost) every property, proposition, and expressions of other functional types. Then there are cardinality issues that must be faced under threat of paradox, and the nominalization operation cannot be a total function. (Cresswell 1973, Chierchia and Turner 1988). I will ignore those issues.
 - Proposals concerning the domain for **type t** have been more varied: truth-values, sets of assignment functions, functions from possible worlds to truth-values, propositions taken as primitives, probably others.
 - In a certain sense Montague had a third basic type, the type of possible worlds; in Gallin’s Ty2 (Gallin 1975) this is explicit. But that is not essential, since on some alternatives the basic type t is taken to be the type of propositions, inherently intensional.
 - There have also been proposals for adding something like situations or eventualities as an additional basic type, and sometimes times. Arguments for or against various choices have usually been arguments from elegance of resulting analyses, not arguments claiming conceptual necessity. This talk is based on a short paper in which I consider whether a language with all the expressive power of our familiar natural languages could in principle be based on a single semantic type (Partee 2006).

2. Thought experiments: “Monocategoric”? and just one basic semantic type?

Suppose we imagine neutralizing the syntactic distinction between NPs and S’s, as in Carstairs-McCarthy’s thought-experiment language Monocategoric. Here are two examples, with **argument-takers** written in SMALL CAPS, and with alternative possible English meanings written below the first example.

- (1) (a) [you snake SEE] YESTERDAY
 (i) ‘You saw a snake yesterday.’ (“sentence” (in English))
 (ii) ‘your seeing a snake yesterday’ (“event-denoting noun phrase”)
 (iii) ‘the snake you saw yesterday’³ (“concrete noun phrase”)
 (iv) ‘you who saw a snake yesterday’ (“concrete noun phrase”)
 ...
 (c) John Mary [[you snake SEE] YESTERDAY] TELL [Carstairs-McCarthy 1999, p.23]

➤ Can we similarly imagine single neutralized basic semantic type?

Since Carstairs-McCarthy countenances distinguishing ‘argument-takers’ from their arguments, we are not being asked to give up functional types, although we could imagine following Chierchia and Turner and not require functions to be of different types from their arguments and try to get along with just one type altogether.

It might be possible to put together several lines of recent research to come up with a defense of the conceptual possibility of getting along without the e – t distinction without losing expressive power. I offer some notes in this direction.

3. Ingredients for a possible one-basic-type semantics

3.1. Neo-Davidsonian semantics of event sentences.

Davidson’s (1967) proposal:

- (2) a. Jones buttered the toast
 b. Jones buttered the toast slowly in the bathroom with a knife.
 (3) a. $\exists e$ [BUTTERING (e,j,t) & BEFORE(e, now)] (Davidson 1967)
 b. $\exists e$ [BUTTERING (e,j,t) & SLOWLY(e) & IN(e,b) & WITH(e,k) & BEFORE(e, now)]
 c. $\exists e$ (BUTTERING (e) & AGENT (e,j) & PATIENT (e,t) & IN(e,b) & WITH(e,k) & BEFORE(e, now)) (Parsons 1985) (“neo-Davidsonian”)

Sentences become similar to indefinite (existential) noun phrases, stating the existence of an event of a certain sort. (Davidson 1967, Parsons 1985, Bach 1986, Kratzer 1996)

3.2. Kamp-Heim semantics for indefinite NPs

Irene Heim’s and Hans Kamp’s semantics for indefinite noun phrases (Kamp 1981, Heim 1982, Heim 1983) removed the existential quantifier from the interpretation of the NP, making the NP more like an open sentence. On the Kamp-Heim theory, the semantic interpretation of (4) is (5b), rather than the classic (5a).

³ The possibility of the readings indicated in (iii) and (iv) with the given bracketing are argued for by appealing to the phenomenon of head-internal relative clauses. This may or may not be reasonable, but it is probably orthogonal to the issue of S and NP as basic categories and t and e as basic types.

- (4) *A cat walked in*
 (5) a. Classic: $\exists x$ (cat (x) & walk-in (x))
 b. Kamp-Heim: cat (x) & walk-in (x)

The free variable may be bound by a higher operator, e.g. an adverbial quantifier. In a simple sentence like (4), implicit existential quantification comes from the definition of what it is for a file (Heim) or a Discourse Representation Structure (Kamp) to be true in a model: there must be some assignment of variables that satisfies it.

Put this together with neo-Davidsonian semantics for event sentences:

- (6) a. Jones buttered the toast
 b. BUTTER(e,j,t) & BEFORE(e, now)

3.3. Open formulas are “almost” type-neutral

An open formula like (5b) (or (6b)) is easy to shift into expressions of various types:

- existential closure gives a proposition : $\exists x$ (cat (x) & walk-in (x))
- a lambda operator gives a property of cats: λx (cat (x) & walk-in (x))
- an iota operator gives (if defined) the entity ‘the cat that walked in’: ιx (cat (x) & walk-in (x))
- a choice function gives an indefinite cat that walked in : ηx (cat (x) & walk-in (x))
- suitable interrogative operators could ask whether a cat walked in or what cat walked in. $?(cat (x) \& walk-in (x))$ or $?x (cat (x) \& walk-in (x))$

In terms of potential interpretations via such operators, the open formula is in a sense already neutral among a range of types, even though when understood as a formula of a familiar logic it has a definite type.

3.4. Exploit the similarities and shiftability among entities and events: “situations”.

It often been noticed how easy it sometimes is to view something either as an “entity” or as an “event” (Bach 1986, Krifka 1989, Partee 1991a).

- Consider “thunderstorms”. When we are in a fixed location, a thunderstorm is an *event* with a *beginning* and an *end*, having a certain *duration*. But for a pilot in an airplane, a thunderstorm is “something” that he can see in a certain *location*, with certain *spatial* dimensions, and he can choose to fly *around* it or to go *through* it.
 - All propositions can be nominalized: *Jones’s buttering of the toast*. Whenever we want to talk *about* an event, we nominalize. When we just want to remark that an event occurred, we use a sentence.
 - It’s not so easy to “propositionalize” an arbitrary entity, but with some artificiality, it could probably be done. Cf. Quine on eliminating proper names: “Pegasizing”
- (7) a. Pegasus flies
 b. standard: FLIES(Pegasus)
 c. “Pegasizing” the name away: $\exists x$ (FLIES(x) & Pegasizes(x))
 where “Pegasize(x)” is true of Pegasus and nothing else.

- The notion of *situation* as used by Kratzer is different from classical notions of events or (Bach) eventualities; situations are parts of possible worlds, but they can be event-sized, person-sized, or larger or smaller. ‘Situation’ might be a good candidate for the most ontologically neutral term.

3.5. *Shiftability between entities and properties.*

Bach et al (1995a) suggest that common nouns are the basic sortal predicates for describing entities, and verbs the basic sortal predicates for describing eventualities.

(8) Гипотезы (Langacker 1987, Partee 1991b, Bach et al. 1995a)

- (i) NPs обозначают или описывают сущности (entities);
- (ii) Предложения обозначают или описывают события или ситуации;
- (iii) Существительные выражают предикаты на сущностях;
- (iv) Глаголы выражают предикаты на событиях или ситуациях.

Bach et al (1995a) also note that the distinction between **proper names** and **common nouns** does not seem nearly as basic in natural languages as it is taken to be by philosophers – natural languages are much more likely make a grammatical distinction between nouns and verbs (both one-place predicates for the logician) than between “Noun Phrase” and “Common noun phrase” (*the king* vs. *king*, *John* vs. *king*). (This is especially clear for Russian, which lacks articles like *the* and *a*.)

- So the distinction between entities and properties of entities does not seem crucial.
- And if the distinction between entities and eventualities might be just a sortal distinction, and the distinction between eventualities and their properties also need not be sharp, then we may be very close to a single “neutral” basic type.

3.6. *Basic type might be type of properties of situations.*

Then a single basic type might be the type of *situations*, conceived of as neutral between entities and eventualities, or, probably a better choice, a type of *properties of situations*, since it seems easier to get from properties to individual situations (via a property analog of ‘singleton set’) than vice versa. We will need properties in any case, since we need argument-takers, and perhaps they are enough, if we follow the lead of Chierchia and Turner and exploit the dual nature of properties as potentially saturated (“nominalized properties”: *goodness*, *running*, *mankind*) or unsaturated (“argument-takers”: *good*, *runs*, *is a man*).

3.7. *Pragmatics can do a lot of the work.*

- Pragmatics already does a lot of work in various places in contemporary semantic/pragmatic theories.
- And it already does in Carstairs-McCarthy’s presentation of how to interpret Monocategoric.
- Given a ‘neutralized’ expression, context and pragmatics might be enough to indicate whether something is being said to “hold” or “be instantiated”, or is being “indicated” (identifying, labeling, etc. uses), or demanded, requested, queried, etc. – all possible independent speech acts -- or is being “considered” or “envisaged” or “mentioned” in various embedded contexts.

- Wittgenstein's primitive "slab" language (Wittgenstein 1953, Part I), while far short of the expressive power of natural languages, exploited context to allow one-word utterances to function as 'mands' ("Bring me X"), and context or overt operators could easily extend this to include offers, assertions, etc.
- We can also argue from our ability to understand children's early utterances. "Up!" "More!" "All-gone?"
- Formally, it also helps that we know how to shift among properties, propositions, and terms via such operations as existential closure, existential disclosure, iota-operators, and other sorts of type-shifters (Partee 1986). Such operators could operate on a pragmatic level in addition to within the semantics. We need both; cf. Frege's careful insistence on the difference between logical negation and the pragmatic speech act of denying.

4. An example

How might the semantics of one part of one of Carstairs-McCarthy's examples go?

- (1) (a) [you snake SEE] YESTERDAY
- (i) 'You saw a snake yesterday.'
 - (ii) 'your seeing a snake yesterday'

Let me use type p as the (basic) type for properties of entities/eventualities/situations.

SEE: type $p \times p \rightarrow p$ Maps a pair of properties p_1 and p_2 of situations onto a new property p_3 which holds of a situation s_3 if s_3 contains situations s_1 and s_2 that have properties p_1 and p_2 respectively and in s_3 (something in) s_1 sees (something in) s_2 .

YESTERDAY: type p . The type of a situation contained in the interval yesterday. On the readings in (i) and (ii) it is conjoined with the property denoted by 'you snake SEE'.

you: type p . The property a situation has if it's a minimal situation containing you. This should go proxy for "you" and the property "being you", neutralized as in Straits Salish (Jelinek 1995).

snake: type p . The property a situation has if it's a snake-containing situation.

[you snake SEE] YESTERDAY : The property a situation has if it's within yesterday and in it a "you" situation (or its contents) sees a "snake" situation (or its contents). Covert or overt operators could then lead to 'asserting the existence of' such a situation (1a-i) or 'referring to' such a situation (1a-ii), without a syntacticized S-NP distinction nor a semanticized t-e distinction.

5. Problems?

What are the main problems to worry about?

- The absence of individual variables? But Polly Jacobson has shown us how not to worry about that with her work on variable-free semantics (Jacobson 1999). Quantification can proceed by unselective adverbial quantification, the favored choice in various languages (Bach et al. 1995b).
- While Carstairs-McCarthy in some places emphasizes how often we get along perfectly well with expressions that are ambiguous or vague, and ontological distinctions that are far from sharp, he also notes that a language without an NP-S distinction can still have an arsenal of explicit operators with interpretations related to focus-marking, question-

marking, sortal specification, and other semantico-pragmatic functions, to reduce vagueness and indeterminacy. In place of truth-conditions and conditions on reference he suggests ‘applicability’ conditions, which could apply equally to proposition-like interpretations and description-like interpretations.

- I would add that we shouldn’t have to give up the centrality of entailment relations: an open formula like that in (5) can have entailments; Groenedijk and Stokhof showed how questions can have entailments (Groenedijk and Stokhof 1989); and I suppose one could just as well say that one description entails another if anything that satisfies the first description (to which the first description applies) satisfies the second.
- What seems plausible to me: just as children’s earliest utterances do not show clear categorization or a clear distinction between “referring” and “asserting”, early language may have managed to develop rather richly without two basic types and without distinguishing syntactically between S and NP. It’s still not clear whether we need to recognize a distinct basic type for “times” in some/all languages: quite possibly not for pidgins and Creoles that don’t have a grammaticized Tense/Aspect system. But it seems that the world’s languages now do all (or perhaps not all, I don’t know) use a system best described as distinguishing NP from S, and given how we understand the semantics behind that syntactic distinction, almost certainly also distinguishing between basic types e and t.

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