Confronting Existential Angst

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1. H∃r∃, Th∃r∃ & ∃v∃rywh∃r∃

When the clock chimed, Miss Scarlet had already poked Colonel Mustard in the library with a pencil.
(*He screamed, but he was fine. No imaginary characters were harmed in producing this handout*.)

(1) a spy poked a soldier
(1a) $\exists x \exists y[\mathrm{Spy}(x)\ \&\ \mathrm{Poked}(x, y)\ \&\ \mathrm{Soldier}(y)]$

(2) a spy poked a soldier in a library with a pencil — see Davidson 67, also Ramsey 27, and Pāṇini
(2a) $\exists e\{\exists x \exists y[\mathrm{Spy}(x)\ \&\ \mathrm{Poked}(e, x, y)\ \&\ \mathrm{Soldier}(y)]\ \&$
$\exists \pi[\mathrm{In}(e, \pi)\ \&\ \mathrm{Library}(\pi)]\ \&\ \exists \pi[\mathrm{With}(e, \pi)\ \&\ \mathrm{Pencil}(\pi)]\}$

$\mathrm{Poked}(e, x, y) \equiv \mathit{Past}(e)\ \&\ \mathrm{PokeByOf}(e, x, y)$

(3) a soldier was poked
(3a) $\exists e\{\mathit{Past}(e)\ \&\ \exists \pi[\mathrm{PokeOf}(e, \pi)\ \&\ \mathrm{Soldier}(\pi)]\}$

(1) a spy poked a soldier
(1a′) $\exists e\{\mathit{Past}(e)\ \&\ \exists \pi[\mathrm{By}(e, \pi)\ \&\ \mathrm{Spy}(\pi)]\ \&\ \exists \pi[\mathrm{PokeOf}(e, \pi)\ \&\ \mathrm{Soldier}(\pi)]\}$

cp. Castañeda 67
Parsons 90
Schein 93
Chomsky 95
Kratzer 96
…

It looks like we need at least this much "thematic decomposition"

(4) a tailor saw a tinker with a tool
(4a) $\exists e\{\mathit{Past}(e)\ \&\ \exists x \exists y[\mathrm{Tailor}(x)\ \&\ \mathrm{SeeOfBy}(e, x, y)\ \&\ \mathrm{Tinker}(y)\ \&\ \exists \pi[\mathrm{With}_{\mathrm{poss}}(y, \pi)\ \&\ \mathrm{Tool}(\pi)]\}$
#(4b) $\exists e\{\mathit{Past}(e)\ \&\ \exists x \exists y[\mathrm{Tailor}(x)\ \&\ \mathrm{SeeOfBy}(e, x, y)\ \&\ \mathrm{Tinker}(y)\ \&\ \exists \pi[\mathrm{With}_{\mathrm{poss}}(x, \pi)\ \&\ \mathrm{Tool}(\pi)]\}$
(4c) $\exists e\{\mathit{Past}(e)\ \&\ \exists x \exists y[\mathrm{Tailor}(x)\ \&\ \mathrm{SeeOfBy}(e, x, y)\ \&\ \mathrm{Tinker}(y)\ \&\ \exists \pi[\mathrm{With}_{\mathrm{instr}}(e, \pi)\ \&\ \mathrm{Tool}(\pi)]\}$

The tailor and tinker might also be magicians who perform a sawing trick.

(4d) $\mathit{Past}(e)\ \&\ \exists x \exists y[\mathrm{Tailor}(x)\ \&\ \mathrm{SawOfBy}(e, x, y)\ \&\ \mathrm{Tinker}(y)\ \&\ \exists \pi[\mathrm{With}_{\mathrm{poss}}(y, \pi)\ \&\ \mathrm{Tool}(\pi)]\}$
#(4e) $\mathit{Past}(e)\ \&\ \exists x \exists y[\mathrm{Tailor}(x)\ \&\ \mathrm{SawOfBy}(e, x, y)\ \&\ \mathrm{Tinker}(y)\ \&\ \exists \pi[\mathrm{With}_{\mathrm{poss}}(x, \pi)\ \&\ \mathrm{Tool}(\pi)]\}$
(4f) $\mathit{Past}(e)\ \&\ \exists x \exists y[\mathrm{Tailor}(x)\ \&\ \mathrm{SawOfBy}(e, x, y)\ \&\ \mathrm{Tinker}(y)\ \&\ \exists \pi[\mathrm{With}_{\mathrm{instr}}(e, \pi)\ \&\ \mathrm{Tool}(\pi)]\}$

If 'see' ('saw') has a variable position for the perceiver (sawyer), why can't that position be modified?

(4a′) $\exists e\{\mathit{Past}(e)\ \&\ \exists \pi[\mathrm{By}(e, \pi)\ \&\ \mathrm{Tailor}(\pi)]\ \&$
$\exists \pi[\mathrm{SeeOf}(e, \pi)\ \&\ \mathrm{Tinker}(\pi)\ \&\ \exists \pi'[\mathrm{With}_{\mathrm{poss}}(\pi, \pi')\ \&\ \mathrm{Tool}(\pi')]\}$

(4c′) $\exists e\{\mathit{Past}(e)\ \&\ \exists \pi[\mathrm{By}(e, \pi)\ \&\ \mathrm{Tailor}(\pi)]\ \&$
$\exists \pi[\mathrm{SeeOf}(e, \pi)\ \&\ \mathrm{Tinker}(\pi)]\ \&\ \exists \pi'[\mathrm{With}_{\mathrm{instr}}(e, \pi')\ \&\ \mathrm{Tool}(\pi')]\}$

Tense also turns out to be interestingly complicated…

$\mathit{Past}(e) \equiv\ \exists \pi[<(e, \pi)\ \&\ \mathit{SpeechTime}(\pi)]$
$\mathit{PastSimple}(e) \equiv\ \exists \pi[<(e, \pi)\ \&\ \mathit{ReferenceTime}(\pi)\ \&\ \exists \pi'[=(\pi, \pi')\ \&\ \mathit{SpeechTime}(\pi')]]$ Reichenbach 47
$\mathit{PastPerfect}(e) \equiv\ \exists \pi[<(e, \pi)\ \&\ \mathit{ReferenceTime}(\pi)\ \&\ \exists \pi'[<(\pi, \pi')\ \&\ \mathit{SpeechTime}(\pi')]]$ Hornstein 90

(5) a guest heard **a scream** in the hall — Higginbotham 83, Vlach 83

$\exists e\{\mathit{PastSimple}(e)\ \&\ \exists\pi[\mathrm{By}(e, \pi)\ \&\ \mathrm{Guest}(\pi)]\ \&$
(a) $\exists\pi[\mathrm{HearingOf}(e, \pi)\ \&\ \mathrm{Scream}(\pi)\ \&\ \text{In-the-hall}(\pi)]\}$
(b) $\exists\pi[\mathrm{HearingOf}(e, \pi)\ \&\ \mathrm{Scream}(\pi)]\ \&\ \text{In-the-hall}(e)\}$

(6) a guest heard **a soldier scream** in the hall

$\exists e\{\mathit{PastSimple}(e)\ \&\ \exists\pi[\mathrm{By}(e, \pi)\ \&\ \mathrm{Guest}(\pi)]\ \&$
(a) $\exists\pi[\mathrm{HearingOf}(e, \pi)\ \&\ \exists\pi'[\mathrm{ScreamBy}(\pi, \pi')\ \&\ \mathrm{Soldier}(\pi')]\ \&\ \text{In-the-hall}(\pi)]\}$
(b) $\exists\pi[\mathrm{HearingOf}(e, \pi)\ \&\ \exists\pi'[\mathrm{ScreamBy}(\pi, \pi')\ \&\ \mathrm{Soldier}(\pi')]]\ \&\ \text{In-the-hall}(e)\}$

at least one '∃' is not due to 'a'

(7) guests heard **screams/guests scream/noises/noise** after hearing doors slam

(7a) $\exists E\{\mathit{PastSimple}(E)\ \&$
$\exists\Pi[\mathrm{By}(E, \Pi)\ \&\ \mathrm{Guests}(\Pi)]\ \&\ \boldsymbol{\exists\Pi}[\mathrm{HearingsOf}(E, \Pi)\ \&\ \mathbf{Screams(\Pi)}]\ \&$
$\exists F\{\mathrm{After}(E, F)\ \&\ \exists\Pi[\mathrm{HearingsOf}(F, \Pi)\ \&\ \exists\Pi'[\mathrm{SlamsOf}(\Pi, \Pi')\ \&\ \mathrm{Doors}(\Pi')]]\}\}$

(8) water trickled

(8a) $\exists E\{\mathit{PastSimple}(E)\ \&\ \exists ?[\mathrm{TricklingOf}(E, ?)\ \&\ \mathrm{Water}(?)]\}$

(9) spy pokes soldier in library

(9a) $\exists e\{\exists\pi[\mathrm{By}(e, \pi)\ \&\ \mathrm{Spy}(\pi)]\ \&\ \exists\pi[\mathrm{PokeOf}(e, \pi)\ \&\ \mathrm{Soldier}(\pi)]\ \&\ \exists\pi[\mathrm{In}(e, \pi)\ \&\ \mathrm{Library}(\pi)]\}$

And don't forget article-free languages, or Kamp-Heim accounts of English indefinites.
It may be that 'a' simply marks nouns as <u>singular</u> (+count, –plural).

(10) $\exists e\{\mathit{PastSimple}(e)\ \&\ \underbrace{\exists\pi[\mathrm{By}(e, \pi)\ \&\ \mathrm{Spy}(\pi)]}_{\text{'a spy'}}\ \&\ \underbrace{\exists\pi[\mathrm{PokeOf}(e, \pi)\ \&\ \mathrm{Soldier}(\pi)]}_{\text{'a soldier'}}\ \&$
$\underbrace{\exists\pi[\mathrm{In}(e, \pi)\ \&\ \mathrm{Library}(\pi)]}_{\text{'a library'}}\ \&\ \underbrace{\exists\pi[\mathrm{With}(e, \pi)\ \&\ \mathrm{Pencil}(\pi)]}_{\text{'a pencil'}}\}$

(11) brown cows (that are) in fields

(11a) $\mathrm{Brown}(X)\ \&\ \mathrm{Cows}(X)\ \&\ \exists\Pi[\mathrm{In}(X, \Pi)\ \&\ \mathrm{Fields}(\Pi)]$

at least often, '∃' is not due to 'a'

(12) see brown beef on brown plates

(12a) $\exists ?[\mathrm{SeeOf}(e, ?)\ \&\ \mathrm{Brown}(?)\ \&\ \mathrm{Beef}(?)\ \&\ \exists\Pi[\mathrm{On}(?, \Pi)\ \&\ \mathrm{Brown}(\Pi)\ \&\ \mathrm{Plates}(\Pi)]]$

$$\begin{array}{ccccc} \exists e[\Phi(e)\ \&\ \Psi(e)\ \&\ \Omega(e)] & \rightarrow & \exists e[\Phi(e)\ \&\ \Psi(e)] & \rightarrow & \exists e[\Phi(e)] \\ & \searrow & & \nearrow & \\ & & \exists e[\Phi(e)\ \&\ \Omega(e)] & & \end{array}$$

familiar network of one-way implications (*Taylor 1983, citing Evans*)

Two Common Patterns: $\underbrace{\Phi(\_)\ \&\ \Psi(\_)}_{\textit{entity/event}}$ $\qquad$ $\exists[\underbrace{\Delta(\_, \_)\ \&\ \Pi(\_)}_{\textit{participant}}]$

2. Who Ordered Those?

Lexicalist Hypotheses: many covert quantifiers and conjoiners

‘brown beef on brown plates’ ➔ (sm) [[brown (nd) beef] [on [(sm) [brown (nd) plates]]]]
‘guests heard guests scream’ ➔ (∃){ [(sm) guests] [heard (∃){[(sm) guests] scream}] }

Type-Shifting Hypotheses: there are no covert quantifiers and conjoiners, but it’s as if there are

$||cow|| = \lambda x.\top \text{ iff } Cow(x)$ $\quad\quad$ $||brown|| = \lambda x.\mathbf{Brown}(x)$

$= \lambda x.\mathbf{Cow}(x)$ $\quad\quad$ ${}^{\uparrow}||brown|| = \lambda \mathbf{\Phi}.\lambda x.\mathbf{\Phi}(x)\ \&\ \mathbf{Brown}(x)$

$$||brown\ cow|| = {}^{\uparrow}||brown||(||cow||) = \lambda \mathbf{\Phi}.\lambda e.\mathbf{\Phi}(e)\ \&\ \mathbf{Brown}(e)(\lambda x.\mathbf{Cow}(x))$$
$$= \lambda e.\lambda x.\mathbf{Cow}(x)(e)\ \&\ \mathbf{Brown}(e)$$
$$= \lambda e.\ \mathbf{Cow}(e)\ \&\ \mathbf{Brown}(e)$$

||brown cow from Texas that arrived|| = ???

And if we want to <u>*explain*</u> *the network of Davidsonian implications, we can’t just say…*

$$||poked\ Mustard\ in\ Devon\ with\ pencils|| = \lambda x.\mathbf{PokedMustardInDevonWithPencils}(x)$$

Combinatorial Hypotheses: some modes of composition are logically substantive

$$||brown_{<et>}\ cow_{<et>}|| = \lambda e.||brown_{<et>}||(e)\ \&\ ||cow_{<et>}||(e)$$
$$= \lambda e.\lambda x.\mathbf{Brown}(x)(e)\ \&\ \lambda x.\mathbf{Cow}(x)(e) = \lambda e.\mathbf{Brown}(e)\ \&\ \mathbf{Cow}(e)$$

$$||[poked\ Mustard]_{<et>}\ [in\ Devon]_{<et>}|| = \lambda e.||[poked\ Mustard]_{<et>}||(e)\ \&\ ||[in\ Devon]_{<et>}||(e)$$
$$= \lambda e.\mathbf{PokeOf}(e, Mustard)\ \&\ \mathbf{In}(e, Devon)$$

But once we grant that combination need not be logically innocent,
it’s no big leap to allow for existential closure as a “default” clausal operation.

And if we go this far, we should at least consider a more revisionary hypothesis.

$\underbrace{\Phi(\_)\ \&\ \Psi(\_)}_{\textit{entity/event}}$ $\quad\quad$ $\exists[\Delta(\_, \underbrace{\_)\ \&\ \Pi(\_)}_{\textit{participant}}]$

both adjunction
and complementation
reflect a combinatorics
that is not logically innocent

—the common patterns reflect operations that are employed at an *early stage* of computation
—other aspects of meaning reflect *other stages* of computation (cp. Chomsky 57, Marr 82)
—not even verb-noun combination is logically innocent
—but maybe we can jettison (logically substantive) appeals to truth values and sets/functions

3. Suggestion from a Long Book (*Conjoining Meanings: Semantics without Truth Values*)

<u>*Simple Typology*</u>:

<M> <D> <M> + <M> ➔ <M> <D> + <M> ➔ <M>

Φ(_) + Ψ(_) ➔ Φ(_)^Ψ(_)
entity/event

Δ(_, _) + Φ(_) ➔ ∃[Δ(_, _)^Φ(_)]
participant

<u>*Core Operations*</u>:

joining two monadic concepts yields a monadic concept that applies to __ if and only if both of the joined concepts apply to __

joining a dyadic concept with a monadic concept yields a monadic concept that applies to __ if and only if __ bears the dyadic relation to *some* thing(s)/stuff that the monadic concept applies to

<u>*Example*</u>:

POKE-OF(_, _) + SOLDIER(_) ➔ ∃[POKE-OF(_, _)^SOLDIER(_)]
IN(_, _) + LIBRARY(_) ➔ ∃[IN(_, _)^LIBRARY(_)]
∃[POKE-OF(_, _)^SOLDIER(_)] + ∃[IN(_, _)^LIBRARY(_)] ➔ ∃[POKE-OF(_, _)^SOLDIER(_)]^∃[IN(_, _)^LIBRARY(_)]

BY(_, _) + SPY(_) ➔ ∃[BY(_, _)^SPY(_)]
PAST-SIMPLE(_) + ∃[BY(_, _)^SPY(_)] ➔ PAST-SIMPLE(_)^∃[BY(_, _)^SPY(_)]

<u>*Main Idea*</u>: in the simplest case (M-junction), combination indicates **restriction**;
in the next simplest case (D-junction), combination still involves restriction
together with a kind of (variable-free) **existential closure**;
this allows for <u>*atomic dyadic*</u> concepts, but the system only <u>*generates monadic*</u> concepts.

On this "neo-Medieval" view, not even verb-noun combination is logically innocent.
By contrast, Fregean *saturation* adds no content.

PRECEDES(_, _) + OSCAR ➔ PRECEDES(_, OSCAR)
PRECEDES(_, OSCAR) + ZIGGY ➔ PRECEDES(ZIGGY, OSCAR)
PRECEDES(_, OSCAR) + SOMETHING[Φ(_)] ➔ SOMETHING[PRECEDES(_, OSCAR)]

any <u>substantive</u> implications are due to <u>atomic</u> expressions

But why expect *natural* modes of combination to be logically innocent?

It's a very old idea that negating, disjoining, and conditionalizing are exceptions to a default principle that combining/lengthening is a way of <u>*strengthening*</u>.
It's also a very old idea that universal quantification is a logically special case, while <u>*existential*</u> quantification is the default way of converting predicates into thoughts.

This invites a pair of "minimalist" questions…

—what would have to be *added*, beyond the Simple Typology and Core Operations, to accommodate cases of quantifier-noun combination as in 'chased *every cow*'?
—would the net result be any *better* than more familiar views that invoke truth values and sets?

4. More Familiar Views and More Angst

(13) every cow is brown

(13a) $\forall$x:Cow(x)[Brown(x)] *each way of assigning a cow to the variable 'x' is a way of assigning a brown thing to 'x'*

(13b) {x: Cow(x)} $\subseteq$ {x: Brown(x)} ➔ $\exists\alpha[\alpha = \{x: \text{Cow}(x)\}]$

(13c) $\lambda\Psi.\lambda\Phi.\top \equiv \{x{:}\Psi(x) = \top\} \subseteq \{x{:}\Phi(x) = \top\}(\lambda x.\mathbf{Cow}(x))(\lambda x.\mathbf{Brown}(x))$ ➔ $\exists\mathbf{F}\forall x{:}\text{Cow}(x)[\mathbf{F}(x) = \top]$

Function Application <u>*is not*</u> *Saturation. Unsaturated slots are not variables, but they are unsaturated.*

PRECEDES(_, _) + $\exists$_[Φ(_)] ➔ ??? *cp.* $\exists$X[PRECEDES(X', X)]

<e, e**t**> + <e**t**, **t**> ➔ ??? $\exists$X[PRECEDES(X, X')]

λX.λX'.$\top$ $\equiv$ PRECEDES(X', X) + OSCAR ➔ λX'.$\top$ $\equiv$ PRECEDES(X', OSCAR) *cp.* PRECEDES(_, OSCAR)]

denoter + *denoter* ➔ *denoter* *unsaturated*

Does (13)—a sentence of *English*—imply that the cows form a *set*?

Does the English sentence itself *imply* that if there are exactly 10 cows, there are at least 14 things:
the 10 cows, the set of those cows, two truth values, and at least one function of type <e, **t**>?

Does (13) imply that if there are exactly 10 cows, there are more than 14 things, including:
the number 10, the ten preceding natural numbers, endlessly many other numbers,
and all the corresponding functions of type <α, β>? (See Appendix B)

Two ways of hearing "Does sentence S imply that p"?

(i) Do competent speakers *comprehend* S as a sentence whose truth logically guarantees that p?
Does S have a **form** that licenses a *secure inference* to the claim that p?

(ii) Is *every world* at which S is true a world at which it is the case that p?
Does S have a **content** that *determines* some (perhaps improper) subset of the p-worlds?

Does 'Scarlet poked Mustard in the library with a pencil' imply that there was a poking of Mustard?

(i) Yes. It has something to do with conjunct reduction. We should try figure out the details.

(ii) Yes. But the sentence also implies that there are infinitely many prime numbers.

Does 'Sadie is a mare' imply that Sadie is a horse? (Short form: does 'mare' imply 'horse'?)

(i) Yes. It has something to do with conjunct reduction. We should try figure out the details.

(ii) Yes. But 'mare' also implies 'mammal such that there are infinitely many prime numbers'.

Does 'Some odd number precedes every prime number' have two readings, with distinct implications?

(i) Yes. And speakers should reject the "surface" reading if they think that 1 is a prime number.

(ii) No. Even if there are two readings, they have the same implications.

5. Analogy: Proportional Angst

(14) Most of the dots are blue

(14a) ?x:Dot(x)[Blue(x)] *see Rescher, Wiggins*
(14b) $\#\{x: Dot(x) \& Blue(x)\} > \#\{x: Dot(x) \& {\sim}Blue(x)\}$

(14c) OneToOnePlus[$\{x: Dot(x) \& Blue(x)\},\{x: Dot(x) \& {\sim}Blue(x)\}$] *no <u>numeric</u> representations*
(14d) $\#\{x: Dot(x) \& Blue(x)\} > \#\{x: Dot(x)\} - \#\{x: Dot(x) \& Blue(x)\}$ *no <u>negation</u>*

Let's agree that (14) is not understood in any "first order" way.

Is (14) understood as implying that the blue dots form a <u>set</u>?
Is (14) understood as implying that the <u>dots that aren't blue</u> form a set?
Is (14) understood as implying that <u>the dots</u> and <u>the dots that are blue</u> have <u>cardinalities</u>?

According to Lidz et. al., (14) is understood as indicated with (14d), as opposed to (14c) or (14b). On this view, (14) implies that there are some numbers, *but not* that the non-blue dots form a set. This view may be wrong; the evidence that Lidz et. al. offer is not decisive. The point here is simply that the issue is empirical. Speakers understand expressions as they do. The goal—for cognitive scientists—is to figure out how; cp. Chomsky 1957. (We can talk about other projects in the Q&A.)

In (14d), the relevant numbers are represented as cardinalities *of sets*. But in the spirit of Lidz et. al., we can compare (14d) with (14e) and ask further empirical questions.

(14d) $\#\{x: Dot(x) \& Blue(x)\} > \#\{x: Dot(x)\} - \#\{x: Dot(x) \& Blue(x)\}$
(14e) $\exists Y\{\forall x(Yx \equiv Dot(x)) \& \exists X[\forall x(Xx \equiv Yx \& Blue(x)) \& \{\#(X) > \#(Y) - \#(X)\}]\}$

there are some things, the Ys, such that: each thing is one of them$_Y$ iff it is a dot; *and*
there are some things, the Xs, such that each thing is one of them$_X$ iff it is one of the Ys and blue, *and* their$_X$ number exceeds the result of subtracting their$_X$ number from the number of the Ys

Read this way, (14e) implies that there are some dots and some numbers, but not that there are any sets. So we have to *justify* claims according to which (14) is *understood as implying* that there are some sets.

6. Bigger Variables, not Bigger Domains

There's a way of interpreting the formalism in (14e) that makes (14e) *different* than (14d), at least given the usual way of interpreting the formalism in (14d). We're not obliged to treat the upper-case variables in (14e) as ranging over sets or other "pluralities;" see Boolos (1998), Schein (1993), Pietroski (2005).

We don't have to say that each assignment of values to variables assigns exactly *one* thing to each variable, and that special *entities* get assigned to upper-case variables. We can say instead that each assignment assigns *one or more things* to each variable, allowing for special cases:
lower case (first-order) variables impose a constraint of *singularity*—i.e., the one or more values assigned are *not more than one*; upper case (second-order) variables are neutral; but "essentially plural" expressions, like 'formed a trio', require that their one or more values be *more than one.*

Assignments of values to variables can be depicted many ways, including the two shown below.

		abcd			
	abc	**abd**	acd	bcd	
ab	ac	ad	bd	bc	cd
a		b		c	d

	0001	0010	0011
0100	0101	0110	0111
1000	1001	1010	**1011**
1100	1101	1110	1111

The diagram on the left invites a "lattice" conception of assignments; see Cartwright 1965, Link 1983. The bottom row is for things in the basic domain. Every other lattice-point indicates an entity in an extended domain that includes sets or "sums" of basic entities—e.g., {a, b, d} or a⊕b⊕d. The bottom row also corresponds to the "singletons" of the extended domain. We can say that each assignment assigns an entity *in the extended domain* to each second-order (capitalized) variable. But invoking more things is not mandatory. We can view 'abd' as an *assignment of three (basic) entities* to an unsingular variable. Recoding in binary makes this vivid: a = 1; b = 10; c = 100; d = 1000. Then '1011' indicates *for each entity*, whether or not it is <u>*one of*</u> the <u>one or more assigned values</u>: d, yes; c, no; b, yes; a, yes.

Are the meanings of *natural* linguistic expressions
better described in terms of *extended domains* or *plural assignments*?
There is a difference, even if for many purposes, we can talk either way.

(15) ∃X∀x[Xx ≡ (x ∉ x)]   *stipulated domain*: Gott, Bert (and nothing else)
facts: Gott ∉ Gott; Bert ∉ Bert; Gott ≠ Bert

Given the stipulated domain and the set-theoretic construal, (15) is **false**.
But given the same domain and the Boolos construal, (15) is **true**.
While nothing in this domain includes Gott and Bert, there are some thing*s*—viz., Gott and Bert—
such that each thing (in the domain) is one of *them* if and only if it isn't selfelemental.
Now suppose that Gott = ∅, Bert = {∅}, and
the domain is extended to include all of the other pure Zermelo-Frankl sets (but nothing else).
Given the Boolos construal, (15) is still **true**, while (15) is still **false** on the set-theoretic construal.
If some domain makes a sentence true on interpretation **I** and false on interpretation **I'**, then **I** ≠ **I'**.

Many facts suggest that the Boolos construal is distinctive and attractive for many purposes.

(16) ∃x(Fx) ≡ ∃X∀x(Xx ≡ Fx)   (*trivial* on the Boolos construal)
(17) ∀X~∃x(Xx & ~Xx)   (fully *general* on the Boolos construal)
(18) ~∃X∃x(Xx & ~Xx)
(19) ~∃🖐∃☝[OneOf(☝, 🖐) ≡ ~OneOf(☝,🖐)]

(20) ~∃<u>s</u>∃x[(x ∈ <u>s</u>) & ~(x ∈ <u>s</u>)]   (trivial, but not fully general)
(21) ~∃y∃x[In(x, y) & ~In(x, y)]

(22) every set is grounded
(22a) {x: x is a set} ⊆ {x: x is grounded}
(22b) ∃Y{∀x(Yx ≡ Set(x)) & ∃X[∀x(Xx ≡ Yx & Grounded(x)) & every Y is an X]}

(23) every set is a set

seems <u>*truistic*</u>*, even if you think that nothing includes every set*

(24) Some barber shaves all and only the barbers who do not shave themselves.

seems <u>*false*</u> *after thinking: any such barber would be a self-shaver who is not a self-shaver*

(25) Vulcan is smaller than Neptune	*false, or at least a false presupposition*
(26) Vulcan is Vulcan	*false, or at least a false presupposition*
(27) All sets are sets	*seems trivial and true, even after thinking*
(28) All sets are grounded sets	*seems at least plausible, even after thinking*

Positing implications that *can't* be recognized is a Risky Game. Imagine a Montagovian field linguist on Planet Tarski, where sentences like (29) do not imply the existence of any sets or truth values.

(29) Fa (29a) $\lambda x.\top$ iff Fish(x)(Aristotle)

Maybe (30) implies that Aristotle is *one of* the fish, but not that he is *an element of (the set of)* the fish.

(30) Aristotle is a fish (30a) Aristotle $\in$ {x: x is a fish}

7. Compensating for Lost Innocence: Limited Quantification without Generalized Quantifiers

(31) every cow ran
(32) every cow is a cow that ran

(33) $\{x: Cow(x)\} \subseteq \{x: Ran(x)\}$ *equivalent for* '$\subseteq$' *but not for* '$\supseteq$' or '='
(34) $\{x: Cow(x)\} \subseteq \{x: Cow(x) \ \& \ Ran(x)\}$

(35) $\exists Y\{\forall x(Yx \equiv Cow(x)) \ \& \ \exists X[\forall x(Xx \equiv Yx \ \& \ Ran(x)) \ \& \ \forall x{:}Yx(Xx)]\}$
(14e) $\exists Y\{\forall x(Yx \equiv Dot(x)) \ \& \ \exists X[\forall x(Xx \equiv Yx \ \& \ Blue(x)) \ \& \ \{\#(X) > \#(Y) - \#(X)\}]\}$

(36) every cow which ran *OK as a restricted quantifier,* <u>*but not*</u> *as a sentence*
(37) $*[_S \text{ [every cow]}_{QP} \text{ [which ran]}_{RC}]$
(38) $[_{\langle \mathbf{t} \rangle} \text{[every cow]}_{\langle \mathbf{et}, \mathbf{t} \rangle} \text{ [which ran]}_{\langle \mathbf{et} \rangle}]$ *should be OK, or at least comprehensible, as a sentence*

(39) Finn chased every cow
(40) $\exists Y\{\forall x(Yx \equiv Cow(x)) \ \& \ \exists X[\forall x(Xx \equiv Yx \ \& \ Chased(Finn, x)) \ \& \ \forall x{:}Yx(Xx)]\}$

Can (39) be understood *compositionally* in the way suggested by (40)?
And won't any remotely plausible proposal take us *far* beyond the common patterns we started with?

$\Phi(\_) \ \& \ \Psi(\_)$ $\exists[\Delta(\_, \_) \ \& \ \Pi(\_)]$

entity/event *participant*

First Step: Treat Sentences as Polarized Predicates

(41) Finn chased Bess

(42) $||[_S \text{ Finn chased Bess}]||^{\mathcal{A}} = \top$ iff CHASED(FINN, BESS)

(43) Val(_, $[_S$ Finn chased Bess]$)^{\mathcal{A}}$ iff CHASED(FINN, BESS)

Instead of saying that (41) denotes a truth value, we can say that (41) applies to everything or nothing, depending on whether or not Finn chased Bess. On this Tarskian view, if Finn chased Bess, then (41) applies to you, me, Finn, Bess, the number six, etc. (In general: if **P**, then we're all such that **P**.) Similarly, we can say that relative to any particular assignment, (44) applies to everything or nothing.

(44) Finn chased it_1

(45) Val(_, $[_S$ Finn chased $it_1])^{\mathcal{A}}$ iff CHASED(FINN, $\mathcal{A}[1]$)

In which case, relative to each assignment $\mathcal{A}$, (44) applies to $\mathcal{A}[1]$—and everything else—if and only if Finn chased $\mathcal{A}[1]$. So we don't need truth values, together with lambda abstraction, to accommodate relative clauses. Given (46), 'which Finn chased' applies to an entity if and only if Finn chased it.

(46) Val(_, [$which_1$ $[_S$ Finn chased $t_1]])^{\mathcal{A}}$ iff

for some/the assignment $\mathcal{A}^*$ such that =(_, $\mathcal{A}^*[1]$) & $\mathcal{A}^*$ is otherwise just like $\mathcal{A}$,

Val($\mathcal{A}^*[1]$, $[_S$ Finn chased $t_1])^{\mathcal{A}^*}$

When we're not worrying about truth values or sets, we can replace (46) with (47).

(47) $||\text{which}_1\ [_S \text{ Finn chased } t_1]||^{\mathcal{A}} = \lambda x.\ \top$ iff CHASED(FINN, x)

But (47) is no *simpler* than (46). Relative to any assignment $\mathcal{A}$, 'λx. $\top$ iff CHASED(FINN, x)' is shorthand for the following mouthful: the smallest function that maps each entity *e* to $\top$ or $\perp$ depending on whether or not 'CHASED(FINN, x)' is satisfied by the 'x'-variant of $\mathcal{A}$ that assigns *e* to 'x'

Though before trying to run without sets/functions, let's be clear that we can walk without truth values, at least if we assume that quantifiers displace as in (48).

(48) $[_S$ [$every_Q$ $cow_N]_{Q1}$ $[_S$ Finn chased t_1]]

And for *these* purposes, let's not worry about *how* CHASED(FINN, $\mathcal{A}[1]$) gets spelled out eventishly.

(49) ∃e{SIMPLE-PAST(E) & CHASE(E, FINN, $\mathcal{A}[1]$)}

(49a) ∃e{SIMPLE-PAST(E) & BY(E, FINN) & CHASE-OF(E, $\mathcal{A}[1]$)}

(49b) ∃_{SIMPLE-PAST(_)^∃[BY(_, _)^=(_, FINN)]^∃[CHASE-OF(_, _)^=(_, $\mathcal{A}[1]$)]}

(49c) ⇑{SIMPLE-PAST(_)^∃[BY(_, _)^=(_, FINN)]^∃[CHASE-OF(_, _)^=(_, $\mathcal{A}[1]$)]}

where ⇑{Φ(_)} is a polarized predicate that applies to everything or nothing, depending on whether or not Φ(_) applies to something.

1. $\mathrm{Val}(\langle\alpha, \beta\rangle, \mathrm{every}_{Q})^{\mathcal{A}}$ iff $\alpha \supseteq \beta$ [*axiom*]

2. $\mathrm{Val}(\_, \mathrm{cow}_{N})^{\mathcal{A}}$ iff $\text{COW}(\_)$ [*axiom*]

3. $\mathrm{Val}(\alpha, [\ldots_{Q} \ldots_{N}]_{Qi})^{\mathcal{A}}$ iff $\exists\beta[\mathrm{Val}(\langle\alpha, \beta\rangle, \ldots_{Q})^{\mathcal{A}} \,\&\, \beta = \{x: \mathrm{Val}(x, \ldots_{N})^{\mathcal{A}}\}]$ [*axiom*]

4. $\mathrm{Val}(\alpha, [\mathrm{every}_{Q}\ \mathrm{cow}_{N}]_{Qi})^{\mathcal{A}}$ iff $\alpha \supseteq \{x: \text{COW}(x)\}$ [1, 2, 3]

5. $\mathrm{Val}(\_, [_{S}\, [\ldots]_{Qi}\, [_{S} \ldots t_{i} \ldots]])^{\mathcal{A}}$ iff

$\exists\alpha[\mathrm{Val}(\alpha, [\ldots]_{Qi})^{\mathcal{A}} \,\&\, \alpha = \{x: \exists\mathcal{A}^*[\mathcal{A}^*[i] = x \,\&\, \mathcal{A}^* \approx_i \mathcal{A}^* \,\&\, \mathrm{Val}(\mathcal{A}^*[i], [_{S} \ldots t_i \ldots])^{\mathcal{A}^*}]\}]$ [*axiom*, cp. 46]

6. Val(_, [$_{S}$ Finn chased t_1])$^{\mathcal{A}^*}$ iff CHASED(FINN, $\mathcal{A}^*[1]$) [*Appendix A*]

7. Val(_, [$_{S}$ [every$_{Q}$ cow$_{N}$]$_{Q1}$ [$_{S}$ Finn chased t_1]])$^{\mathcal{A}}$ iff

$\exists\alpha[\alpha \supseteq \{x: \text{COW}(x)\} \,\&\, \alpha = \{x: \exists\mathcal{A}^*[\mathcal{A}^*[1] = x \,\&\, \mathcal{A}^* \approx_1 \mathcal{A}^* \,\&\, \text{CHASED}(\text{FINN}, \mathcal{A}^*[1])]\}]$ [4, 5, 6]

$= \{x: \exists\mathcal{A}^*[\quad \mathcal{A}^* \approx_1 \mathcal{A}^* \,\&\, \text{CHASED}(\text{FINN}, \quad x\ )]\}]$ cp. Larson &

$= \{x: \quad \text{CHASED}(\text{FINN}, \quad x\ )\ \}]$ Segal (1995)

7a. $\mathrm{Val}(\_, [_{S}\, [\mathrm{every}_{Q}\ \mathrm{cow}_{N}]_{Q1}\, [_{S}\ \text{Finn chased } t_1]])^{\mathcal{A}}$ iff $\{x: \text{CHASED}(\text{FINN}, x)\} \supseteq \{x: \text{COW}(x)\}$ [7, abbreviated]

Second Step: Treat Quantifiers as Plural Predicates

Rewrite the axiom for ‘every’: $\mathrm{Val}(O, \mathrm{every}_{Q})^{\mathcal{A}}$ iff $\exists X\exists Y[\mathrm{Externals}(O, X) \,\&\, \mathrm{Internals}(O, Y) \,\&\, \forall x{:}Yx(Xx)]$

For any ordered pair $\langle e, i\rangle$—a.k.a. $\{e, \{e, i\}\}$—e is the pair’s external element.

But we don’t have to say that the Os are *pairs of sets* that meet a certain set-theoretic condition.
Let the Os be *pairs of entities* that meet a plural condition: each of their Internals is one of their Externals.

$\text{EVERY}(O)$ iff $\exists X\exists Y\{\forall x(Xx \equiv \exists o{:}Oo[\text{EXTERNAL}(o, x)]) \,\&\, \forall y(Yy \equiv \exists o{:}Oo[\text{INTERNAL}(o, y)]) \,\&\, \forall x{:}Yx(Xx)\}$

$\exists X\exists Y\{\quad \text{EXTERNALS}(O, X) \,\&\, \quad \text{INTERNALS}(O, Y) \,\&\, \forall x{:}Yx(Xx)\}$

Now we can rewrite the derivation above without assuming an extended domain that includes a set of cows.

1. $\mathrm{Val}(O, \mathrm{every}_{Q})^{\mathcal{A}}$ iff $\text{EVERY}(O)$ [*axiom*]

2. $\mathrm{Val}(\_, \mathrm{cow}_{N})^{\mathcal{A}}$ iff $\text{COW}(\_)$ [*axiom*]

3. $\mathrm{Val}(O, [\ldots_{Q} \ldots_{N}]_{Qi})^{\mathcal{A}}$ iff $\mathrm{Val}(O, \ldots_{Q})^{\mathcal{A}} \,\&\, \exists Y[\text{INTERNALS}(O, Y) \,\&\, \forall y(Yy \equiv \mathrm{Val}(y, \ldots_{N})^{\mathcal{A}})]$ [*axiom*]

4. $\mathrm{Val}(O, [\mathrm{every}_{Q}\ \mathrm{cow}_{N}]_{Q1})^{\mathcal{A}}$ iff $\text{EVERY}(O) \,\&\, \exists Y[\text{INTERNALS}(O, Y) \,\&\, \forall y(Yy \equiv \text{COW}(y))]$ [1, 2, 3]

4a. $\mathrm{Val}(O, [\mathrm{every}_{Q}\ \mathrm{cow}_{N}]_{Q1})^{\mathcal{A}}$ iff $\text{EVERY}(O) \,\&\, \iota Y{:}\mathrm{Cows}(Y)[\text{INTERNALS}(O, Y)]$ [4, abbreviated]

5. $\mathrm{Val}(\_, [_{S}\, [\ldots]_{Qi}\, [_{S} \ldots t_{i} \ldots]])^{\mathcal{A}}$ iff $\exists O\{\mathrm{Val}(O, [\ldots]_{Qi})^{\mathcal{A}} \,\&\, \exists X[\text{EXTERNALS}(O, X)\, \&$

$\forall x(Xx \equiv \exists\mathcal{A}^*[\mathcal{A}^*[i] = x \,\&\, \mathcal{A}^* \approx_i \mathcal{A}^* \,\&\, \mathrm{Val}(\mathcal{A}^*[i], [_{S} \ldots t_i \ldots])^{\mathcal{A}^*}])\}$ [*axiom,* cp. (46)]

6. $\mathrm{Val}(\_, [_{S}\ \text{Finn chased } t_1])^{\mathcal{A}^*}$ iff $\text{CHASED}(\text{FINN}, \mathcal{A}^*[1]))$ [*Appendix A*]

7. $\mathrm{Val}(\_, [_{S}\, [\mathrm{every}_{Q}\ \mathrm{cow}_{N}]_{Q1}\, [_{S}\ \text{Finn chased } t_1]])^{\mathcal{A}}$ iff

$\exists O\{\text{EVERY}(O) \,\&\, \iota Y{:}\mathrm{Cows}(Y)[\text{INTERNALS}(O, Y)]\ \&$

$\exists X[\text{EXTERNALS}(O, X) \,\&\, \forall x(Xx \equiv \exists\mathcal{A}^*[\mathcal{A}^*[1] = x \,\&\, \mathcal{A}^* \approx_1 \mathcal{A}^* \,\&\, \text{CHASED}(\text{FINN}, \mathcal{A}^*[1])])]\}$ [4, 5, 6]

$\equiv \exists\mathcal{A}^*[\quad \mathcal{A}^* \approx_1 \mathcal{A}^* \,\&\, \text{CHASED}(\text{FINN}, x) \quad])]\}$

$\equiv \quad \text{CHASED}(\text{FINN}, x) \quad)]\}$

7a. $\mathrm{Val}(\_, [_{S}\, [\mathrm{every}_{Q}\ \mathrm{cow}_{N}]_{Q1}\, [_{S}\ \text{Finn chased } t_1]])^{\mathcal{A}}$ iff

$\exists O\{\text{EVERY}(O) \,\&\, \iota Y{:}\mathrm{Cows}(Y)[\text{INTERNALS}(O, Y)] \,\&\, \iota X{:}\text{CHASED}(\text{FINN}, X)[\text{EXTERNALS}(O, X)]\}$ [7, abb.]

But this still doesn't capture the restricted/conservative character of quantificational determiners.
The axiom for 'every' allows for ordered pairs such that some of their external elements

are not among their internal elements. (Finn may have chased many things that are not cows.)

And the external/sentential argument of 'every' was treated as if it were the relative clause in (50).

(50) every cow which Finn chased

That's almost as bad as appealing to quantifier raising *and* the idea that 'every cow' is of type <**e**t, **t**>. But the goal is not to recode this idea, with all its warts, a little more austerely. The "mimimalist" hope is that aiming for austerity will help identify which aspects of our notation do the explanatory work.

We want to know *why* quantificational determiners "live on" their internal arguments;

cp. Barwise & Cooper (1981), Higginbotham & May (1981), Keenan & Stavi (1986)

With regard to (48), we want to explain the *semantic asymmetry* between cow_{N} and $[_{\text{S}}$ Finn chased $t_1]$.

(48) $[_{\text{S}}\ [\text{every}_{\text{Q}}\ \text{cow}_{\text{N}}]_{\text{Q}1}\ [_{\text{S}}\ \text{Finn chased } t_1]]$

So if the displaced quantifier recombines with the *sentence* from which it was displaced, maybe we don't want a semantics that *erases this grammatical asymmetry* as in (51); cp. Heim & Kratzer (1998).

(51) $[_{<\mathbf{t}>}\ [\text{every}_{<\mathbf{e}t,\ <\mathbf{e}t,\ \mathbf{t}>>}\ \text{cow}_{<\mathbf{e}t>}]_{<\mathbf{e}t,\ \mathbf{t}>}\ [_{<\mathbf{e}t>}\ 1\ [_{<\mathbf{t}>}\ \text{Finn chased } t_1]]]$

Maybe we should return to (40)—a claim about *the cows*, with no reference to *the things Finn chased*…

(40) $\exists Y\{\forall x(Yx \equiv \text{Cow}(x))\ \&\ \exists X[\forall x(Xx \equiv Yx\ \&\ \text{Chased}(\text{Finn}, x))\ \&\ \forall x{:}Yx(Xx)]\}$

(40a) $\iota Y{:}\text{Cows}(Y)\{\exists X[\forall x(Xx \equiv Yx\ \&\ \text{Chased}(\text{Finn}, x))\ \&\ \forall x{:}Yx(Xx)]\}$

… *and no reference to any relation* exhibited by the (set of) cows and the (set of) things Finn chased.

So let me end with two suggestions—perhaps notational variants—about how to get from (48) to (40).

(52) $\text{Val}(\text{O}, [\ldots_{\text{Q}} \ldots_{\text{N}}]_{\text{Q}i})^{\mathcal{A}}$ iff

$\text{Val}(\text{O}, \ldots_{\text{Q}})^{\mathcal{A}}\ \&\ \exists Y[\text{Internals}(\text{O}, Y)\ \&\ \forall y(Yy \equiv \text{Val}(y, \ldots_{\text{N}})^{\mathcal{A}})\ \boldsymbol{\&\ \text{ExternalsAreInternals}(\text{O})}]$

(53) $\text{Val}(\_, [_{\text{S}}\ [\ldots_{\text{Q}} \ldots_{\text{N}}]_{\text{Q}i}\ [_{\text{S}} \ldots t_i \ldots]], \mathcal{A})$ iff

$\exists \text{O}\{\text{Val}(\text{O}, [\ldots]_{\text{Q}i})^{\mathcal{A}}\ \&\ \exists X[\text{Externals}(\text{O}, X)\ \&$

$\forall x(Xx \equiv \exists \mathcal{A}^*{:}x = \mathcal{A}^*[i]\ \boldsymbol{\&\ \text{Val}(\mathcal{A}^*[i], \ldots_{\text{N}})^{\mathcal{A}^*}}\ \&\ \mathcal{A}^* \approx_i \mathcal{A}\ \&\ \{\text{Val}(\mathcal{A}^*[1], [_{\text{S}} \ldots t_i \ldots])^{\mathcal{A}^*}\}))\}$

We can deny that the Os pair their internal entities with independently selected external entities. We need not (and should not) say that quantificational determiners express *second-order relations*. The external/sentential argument—a polarized predicate containing a trace of the displaced quantifier—is used to make a *secondary selection* from values of the internal/nominal argument. On this view, the *combinatorics* ensures conservativity. So while identity is not a conservative second-order relation, we can still specify the meaning of 'every' with an *identity condition*, as opposed to an inclusion condition.

$\text{Val}(\text{O}, \text{every}_{\text{Q}})^{\mathcal{A}}$ iff $\exists Y \exists X[\text{Internals}(\text{O}, Y)\ \&\ \text{Externals}(\text{O}, X)\ \&\ \forall x(Yx \equiv Xx)]$

$\exists Y[\text{Internals}(\text{O}, Y)\ \&\ \text{Externals}(\text{O}, Y)]$

$\iota Y{:}\text{Internals}(\text{O}, Y)[\text{Externals}(\text{O}, Y)]$

Appendix A: Comparing Derivations for ‘Finn chased it’

<u>Axioms</u>

a. Val(_, -d$_T$)$^{\mathcal{A}}$ iff PAST-SIMPLE(_)

a. $\lVert\text{-d}_T\rVert^{\mathcal{A}} = \lambda e.\mathsf{T}$ iff PAST-SIMPLE(e)

b. Val(_, Φ-Finn$_N$)$^{\mathcal{A}}$ iff =(_, R-FINN)

b. $\lVert\Phi\text{-Finn}_N\rVert^{\mathcal{A}}$ = R-FINN

Proper nouns are probably predicative, and they’re surely not atomic expressions of type <e>.

c. for any index *i,* Val(_, t$_i$)$^{\mathcal{A}}$ iff =(_, $\mathcal{A}[i]$)

c. for any index *i,* $\lVert t_i\rVert^{\mathcal{A}} = \mathcal{A}[i]$

d. Val(_, [chase$_V$ …])$^{\mathcal{A}}$ iff
∃[CHASE-OF(_, _)^Val(_, …)$^{\mathcal{A}}$]

d. $\lVert\text{chase}_V\rVert^{\mathcal{A}} = \lambda x.\lambda e.\mathsf{T}$ iff CHASE-OF(e, x)

e. Val(_, [*by*$_v$ …])$^{\mathcal{A}}$ iff ∃[BY(_, _)^Val(_, …)$^{\mathcal{A}}$]

e. $\lVert by_v\rVert^{\mathcal{A}} = \lambda\Phi.\lambda x.\lambda e.\mathsf{T}$ iff BY(e, x) & $\Phi(e) = \mathsf{T}$

f. Val(_, […$_{<M>}$ …$_{<M>*}$])$^{\mathcal{A}}$ iff
Val(_, […$_{<M>}$])$^{\mathcal{A}}$^Val(_, …$_{<M>*}$)$^{\mathcal{A}}$

f. $\lVert[\ldots_{<et>}\ \ldots_{<et>*}]\rVert^{\mathcal{A}} = \lambda x.\mathsf{T}$ iff
$\lVert\ldots_{<et>}\rVert^{\mathcal{A}} = \mathsf{T}$ & $\lVert\ldots_{<et>*}\rVert^{\mathcal{A}} = \mathsf{T}$

g. $\lVert[\ldots_{<\alpha,\beta>}\ \ldots_{<\alpha>}]\rVert^{\mathcal{A}} = \lVert\ldots_{<\alpha,\beta>}\rVert^{\mathcal{A}}(\lVert\ldots_{<\alpha>}\rVert^{\mathcal{A}})$

h. Val(_, [$_\Sigma$ […]])$^{\mathcal{A}}$ iff for some e, Val(e, …)$^{\mathcal{A}}$

h. $\lVert[_\Sigma\ [\ldots]]\rVert^{\mathcal{A}} = \mathsf{T}$ iff for some e, $\lVert\ldots\rVert^{\mathcal{A}}(e) = \mathsf{T}$

```
            Σ (10)
            T  (9)
         /          \
 (8) -dT              v (7)
                  /          \
          (6) v                 V (3)
           /     \            /      \
Φ-FinnN      byv      chaseV      t1
     (4)        (5)       (2)          (1)
```

Val(_, 1)$^{\mathcal{A}}$ iff =(_, $\mathcal{A}[1]$)

Val(_, 3)$^{\mathcal{A}}$ iff ∃[CHASE-OF(_, _)^=(_, $\mathcal{A}[1]$)]

Val(_, 4)$^{\mathcal{A}}$ iff =(_, R-FINN)

Val(_, 6)$^{\mathcal{A}}$ iff ∃[BY(_, _)^=(_, R-FINN)]

Val(_, 7)$^{\mathcal{A}}$ iff ∃[CHASE-OF(_, _)^=(_, $\mathcal{A}[1]$)]^
∃[BY(_, _)^=(_, R-FINN)]

Val(_, 8)$^{\mathcal{A}}$ iff PAST-SIMPLE(_)

Val(_, 9)$^{\mathcal{A}}$ iff PAST-SIMPLE(_)^Val(_, 7)$^{\mathcal{A}}$

Val(_, 10)$^{\mathcal{A}}$ iff for some e, Val(_, 9)$^{\mathcal{A}}$

```
            Σ (10)
            T  (9)
         /          \
 (8)-dT              v (7)
                 /          \
      (6) Φ-FinnN        v (5)
                          /    \
                  (4) byv     V(3)
                              /     \
                    (2) chaseV   t1 (1)
```

$\lVert 1\rVert^{\mathcal{A}} = \mathcal{A}[1]$

$\lVert 2\rVert^{\mathcal{A}} = \lambda x.\lambda e.\mathsf{T}$ iff CHASE-OF(e, x)

$\lVert 3\rVert^{\mathcal{A}} = \lambda e.\mathsf{T}$ iff CHASE-OF(e, $\mathcal{A}[1]$)

$\lVert 4\rVert^{\mathcal{A}} = \lambda\Phi.\lambda x.\lambda e.\mathsf{T}$ iff BY(e, x) & $\Phi(e) = \mathsf{T}$

$\lVert 5\rVert^{\mathcal{A}} = \lambda x.\lambda e.\mathsf{T}$ iff BY(e, x) & CHASE-OF(e, $\mathcal{A}[1]$)

$\lVert 6\rVert^{\mathcal{A}}$ = R-FINN

$\lVert 7\rVert^{\mathcal{A}} = \lambda e.\mathsf{T}$ iff BY(e, R-FINN) & CHASE-OF(e, $\mathcal{A}[1]$)

$\lVert 8\rVert^{\mathcal{A}} = \lambda e.\mathsf{T}$ iff PAST-SIMPLE(e)

$\lVert 9\rVert^{\mathcal{A}} = \lambda e.\mathsf{T}$ iff PAST-SIMPLE(e) & $\lVert 7\rVert^{\mathcal{A}}(e) = \mathsf{T}$

$\lVert 10\rVert^{\mathcal{A}}$ = for some e, $\lVert 9\rVert^{\mathcal{A}}(e) = \mathsf{T}$

Note that blaming __*tense*__ for the matrix ∃-closure
would assign two __*kinds*__ of work to one morpheme: quantification __*and*__ restriction.

[she poke him] ➔ She-poke-him(e)
-ed ➔ $\lambda\Phi.\exists e\{\mathit{PastSimple}(e)\ \&\ \Phi(e)\}$
[-ed [she poke him]] ➔ $\exists e\{\mathit{PastSimple}(e)\ \&\ \text{She-poke-him}(e)\}$

Moreover, the restrictors are not *mere* conjuncts; see Reichenbach/Hornstein.

$$\mathit{PastSimple}(e) \equiv \exists\pi[\text{Before}(e, \pi)\ \&\ \mathit{ReferenceTime}(\pi)\ \&\ \exists\pi'[=(\pi, \pi')\ \&\ \mathit{SpeechTime}(\pi')]]$$

And perceptual reports (e.g., heard him scream') suggest that ∃-closure doesn't require embedded tense; while we can apparently get embedded tense without *existential* closure.

(i) she poked him *before* he screamed
$\exists e\{\text{She-poked-him}(e)\ \&\ \forall\pi{:}\mathit{PastSimple}(\pi)\ \&\ \text{ScreamBy}(\pi, \text{he})[\text{Before}(e, \pi)]\}$

(ii) she poked him *and then* he screamed
$\exists e\{\text{She-poked-him}(e)\ \&\ \exists\pi{:}\mathit{PastSimple}(\pi)\ \&\ \text{ScreamBy}(\pi, \text{he})[\text{Before}(e, \pi)]\}$

Appendix B: The Frege-Church Type Hierarchy

Level Zero: two basic types $\langle e\rangle$ $\langle \mathbf{t}\rangle$

Recursive Principle: if $\langle\alpha\rangle$ *and* $\langle\beta\rangle$ *are types, then* $\langle\alpha, \beta\rangle$ *is a type*

Level One: four $\langle 0, 0\rangle$ types $\langle e, e\rangle$ $\langle e, \mathbf{t}\rangle$ $\langle \mathbf{t}, e\rangle$ $\langle \mathbf{t}, \mathbf{t}\rangle$

Level Two: eight $\langle 0, 1\rangle$ types, which include $\langle e, \langle e, \mathbf{t}\rangle\rangle$ and $\langle \mathbf{t}, \langle \mathbf{t}, e\rangle\rangle$;
eight $\langle 1, 0\rangle$ types, which include $\langle\langle e, e\rangle, e\rangle$ and $\langle\langle \mathbf{t}, \mathbf{t}\rangle, \mathbf{t}\rangle$; and
sixteen $\langle 1, 1\rangle$ types, which include $\langle\langle e, e\rangle, \langle e, e\rangle\rangle$ and $\langle\langle e, \mathbf{t}\rangle, \langle \mathbf{t}, \mathbf{t}\rangle\rangle$

Level Three: sixty-four $\langle 0, 2\rangle$ types, which include $\langle e, \langle e, \langle e, \mathbf{t}\rangle\rangle\rangle$;
sixty-four $\langle 2, 0\rangle$ types, which include $\langle\langle e, \langle e, \mathbf{t}\rangle\rangle, \mathbf{t}\rangle$;
one-hundred-and-twenty-eight $\langle 1, 2\rangle$ types, which include $\langle\langle e, \mathbf{t}\rangle, \langle\langle e, t\rangle, \mathbf{t}\rangle\rangle$;
one-hundred-and-twenty-eight $\langle 2, 1\rangle$ types, which include $\langle\langle e, \langle e, \mathbf{t}\rangle\rangle, \langle e, \mathbf{t}\rangle\rangle$; and
one-thousand-and-twenty-four $\langle 2, 2\rangle$ types, which include $\langle\langle e, \langle e, \mathbf{t}\rangle\rangle, \langle e, \langle e, \mathbf{t}\rangle\rangle\rangle$.

Level Four: 5632 $\langle 0, 3\rangle$ or $\langle 3, 0\rangle$ types, including $\langle e, \langle e, \langle e, \langle e, \mathbf{t}\rangle\rangle\rangle$
11,264 $\langle 1, 3\rangle$ or $\langle 3, 1\rangle$ types;
90,112 $\langle 2, 3\rangle$ or $\langle 3, 2\rangle$ types, including $\langle\langle e, \langle e, \mathbf{t}\rangle\rangle, \langle\langle e, \langle e, \mathbf{t}\rangle\rangle, \mathbf{t}\rangle\rangle$; and
1,982,464 $\langle 3, 3\rangle$ types

Level Five: more than 5×10^{12} types

etc.

Appendix C: Composition as De-Abstraction…Bait and Switch

(1) Finn chased Bess
(1a) [Finn$_{\langle e\rangle}$ [chased$_{\langle e,\ et\rangle}$ Bess$_{\langle e\rangle}$]$_{\langle et\rangle}$]$_{\langle t\rangle}$

What about tense and adverbial modifiers?

(1b) [… [Finn$_{\langle e\rangle}$ [chase$_{\langle e,\ \langle e,\ et\rangle\rangle}$ Bess$_{\langle e\rangle}$]$_{\langle e,\ et\rangle}$]$_{\langle et\rangle}$ …]$_{\langle t\rangle}$

What about passives and other motivations for "severing" external arguments?

(1c) [… [Finn$_{\langle e\rangle}$ [__$_{\langle et,\ \langle e,\ et\rangle\rangle}$ [chase$_{\langle e,\ et\rangle\rangle}$ Bess$_{\langle e\rangle}$]$_{\langle et\rangle}$]$_{\langle e,\ et\rangle}$]$_{\langle et\rangle}$ …]$_{\langle t\rangle}$

Are there any simple cases that <u>motivate</u> the standard typology, in the way that (1) was supposed to?

(2) chase Bess
(2a) [chase$_{\langle e,\ et\rangle}$ Bess$_{\langle e\rangle}$]$_{\langle et\rangle}$

Are names atomic expressions of type <e>? And is (3) as complicated as (3a)? Or is this just a game?

(3) chase cows
(3a) [[(sm)$_{\langle et,\ \langle et,\ t\rangle\rangle}$ [cow$_{\langle et\rangle}$ s$_{\langle et,\ et\rangle}$]$_{\langle et\rangle}$]$_{\langle et,\ t\rangle}$ [1 [… [chase$_{\langle e,\ et\rangle}$ t$_{1\langle e\rangle}$]$_{\langle et\rangle}$ …]$_{\langle t\rangle}$]$_{\langle et\rangle}$]$_{\langle t\rangle}$

References (Very Incomplete…for more, see the list in Pietroski 2018)

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